## The Hooping of the Dome of St. Peter's Rome.

If guide-books and other descriptions of Rome are to be taken as evidence, it would seem that among the "things not generally known," the iron bands which encircle the drum and dome of St. Peter's may be included. Soon after Bernini had made staircases and niches in the great piers it was observed that the cupola was rent, but no importance was attached to the defects. Carlo Fontana was appointed architect in charge of the Basilica, and he wrote a book to give the world assurance of the safety of the building. But in spite of talk and type, the cracks became larger, and in 1742 the subject excited commotion in Rome, when a scientific commission was appointed. The following account of their inquiry was compiled by Cardinal Wiseman from the original reports, and is published as a "Bygone" by the kind permission of Messrs. Hurst & Blackett. We may add that the conclusions of the reverend scientists were generally accepted. Out of nineteen opinions which were obtained on the report, the majority agreed that the hooping was the best device. Giovanni Poleni was, however, summoned from Naples, and he expressed an opinion that the dome was not in danger. He attached no importance to the cracks, which he considered were partly the results of the enlargement of some of the piers, by which they sank more than others, and partly the results of hasty building. The variation of the drum from the perpendicular he ascribed to settlements, and not to the pressure of the superincumbent dome. But as Poleni advised the adoption of five circles of iron around the dome, it may be said that he came to the same conclusion as the mathematicians, who proposed six colossal hoops to give security to the cupola. A sixth was added, and there are now eight. The work was completed in 1747, and was carried out under the direction of Luigi Vanvitelli or Van Witel, the architect of the Caserta Palace, the Convent of Sant' Agostino, and other buildings in Italy. Each hoop consists of thirty pieces, and they are covered with brick in order to be preserved from rust.

There is a popular idea current, that Michel Angelo made the huge piers, on which the dome had to rest, so exactly proportioned to the weight they had to bear, that he even made a dying request that they should never be touched; that they were afterwards perforated to make some staircases and niches, and that the consequence was, that the whole dome was threatened with ruin. All this is incorrect, as I will show you just now. It is not likely that Michel Angelo, whose characteristic was massiveness to excess, would have so offended. But in addition, it deserves to be mentioned that, at the time when he built these piers, a commission was appointed, of which I believe Raffaele was a member, to examine them; and that their report was, that the piers should be still further strengthened. Immensely deep wells were accordingly sunk at their feet, and filled with Roman concrete—which is the strongest I suppose, in the world—so as to give great additional support.

It will be useful to give you the exact dimensions, in English feet, of the great masses concerned in what I am about to speak of.

Piers, on which the dome rests, 282 round.

Cupola, diameter, 141½.

Circumference, about 423.

Heights of arches on which it rests from the pavement 146.

Height of lower edge of dome, 171½.

Total height to summit of lantern, 446½.

Perhaps the greatest promise ever made by art, and faithfully kept, was here. Michel Angelo is said to have declared that he would raise the Pantheon up into the skies. These dimensions show how he kept his word.

About 1681, it was observed that there was numerous cracks in various directions, through the cupola; and great blame was thrown upon Bernini, who was accused of having made dangerous staircases and niches in the piers; however, his friend and biographer, Baldinucci, produced plans of earlier date, in which these alterations were marked; thus disproving that Bernini had been their author. He moreover speaks of the fissures then apparent as trifling. But they went on increasing. What are called in Italy seals—that is, marble dovetails,—were placed across the cracks; and these broke, or were breaking with alarming rapidity. It was evident that the work of destruction was going on; and before the middle of the last century it was feared that, in a few years more, the whole dome of St. Peter's might fall in.

Architects came forward to suggest various remedies for the threatened evil. One wanted to block up the windows, another to make great spurs or buttresses, in addition to the columns that surround the cupola, to give it strength. In truth, the whole structure would have been disfigured by the proposed expedients; but in reality, it was difficult to find a remedy. Benedict XIV., a most able and learned man, was pope at the time. He wisely observed that this was not the business of art, but that it belonged to science. So he named a special commission of three mathematicians—pure mathematicians, having nothing to do with building or architecture, to examine the case. When I mention their names, scientific persons will easily understand how they were selected.

At the head of the commission was Father Boscovich, a Jesuit, who had twice measured arcs of the meridian, and had published a number of works on astronomy, on the spots on the sun, on optics, and many other philosophical subject; a man, in truth, of European reputation, and one of the first men in Italy who accepted the Newtonian system. The other two were not Jesuits, but religious of another order. They were the editors of what is commonly called the Jesuits' Edition of Newton, Le Sueur, and Jacquiert; men purely and exclusively scientific. How did they go about their work? As scientific men would naturally do, with great care and caution, as well as ability.

As they drew up a minute report of their proceedings, under the modest title of "Opinion of Three Mathematicians," and presented it to the pope, I have only to abridge their own account of them. It was given in at the close of 1742; and they commence their paper by apologizing for apparently intruding into a province not their own, and pleading for their excuse the sovereign command; showing, at the same time, how science has properly to deal with such a matter.

Their first care was to examine most minutely the entire dome, within and without, and form thus a plan of all the injuries which it had suffered. They give an accurate list of thirty-two distinct damages, some very severe, and running in various directions. The stone lintels over several of the windows were split in two. And when they applied a plumb-line to the buttress-pillars round the drum, or cylinder, of the dome, these proved to be as much as over an inch out of the perpendicular.

This naturally pointed to the over-pressure of the spheroidal portion, with the lantern above, upon the drum. But our three mathematicians were not satisfied with this simple deduction; they carefully examined the piers to which popular judgment attributed the damage; and they found that judgment to be erroneous. The piers were intact, and required no attention. They therefore advised that nothing should be done to them. Thus having formed the hypothesis of over-pressure they proved that every phenomenon, to the slightest crack, fell into it, and was adequately explained by it, and by no other.

Their next step was to verify most exactly the reality of what they had theoretically ascertained, by weighing, on the one hand, the materials supported, and measuring, on the other, the sustaining power. I will not detain you with details, which are minutely given in the original memoir, but present to you the general results. Having exactly weighed measured portions of the materials used in the construction of this wonderful building—the stone, brick, copper, lead, and iron—and then, from accurate plans, and by sound calculations, having measured the quantity of each, they found that the entire dome, with its lantern, came to the frightful weight of 165,000,000 of Roman pounds, or 55,245 tons.

They obtain separately the weight of the gravitating portion; and then calculate the resistance or supporting powers. This consisted, first, in the drum *(tamburro)*, with its pillars thrust already out of the perpendicular; and secondly, of an iron girder, too slight for its purpose, but so embedded in the wall that it could not be examined. They estimate, however, its tenacity, and take it into reckoning; but conjecture that it had either snapped or dilated, so as to be useless.

But they thus reached the awful result—that there was a balance of 5,000,000 pounds, or 1,674 tons, on the side of pressure against support. The conclusion of the mathematicians was, "that an irreparable ruin was reasonably to be apprehended, unless a timely and efficient remedy were applied."

We may well image the alarm of Rome, with its artistic population, at such an announcement as this; and at hearing that this collapse and ruin had only been prevented so far by an iron collar round the base of the lantern, and by the peculiar construction which united the double dome to this, so as to prevent its falling out.

It is easier to find a defect, and prognosticate misfortune, than to remedy the one or to avert the other. But the commission to the three mathematicians was, not only to probe the evil, but also to suggest its "efficient cure," which they consequently proceeded to do.

Well, what sort of a remedy did they suggest? One entirely scientific, and not a little appalling. It was to put six more solid girders round this huge periphery of 420 feet. Each, of course, was to be divided into several sections, or arcs; and where these met, each had to branch into three; and these branches proceeding from the two arcs, were to be fastened by bolts passing through sockets in them; the bolts again being rivetted to chains passed round the building. A gigantic or Cyclopean undertaking; for you must remember that there were then and there no Nasmyth's hammers, or Birmingham rolling-mills; so that the enormous hoops had all to be forged and shaped by hand.

Of course, no sooner had this report appeared than it was assailed in all its parts—groundwork, deductions, and proposals. To vindicate it, and reply to the objections so gravely urged, and, at the same time, give an account of further proceedings in the matter, a second memoir was drawn up by the same learned men, early in the following year. A meeting of the general committee was then held, comprising architects, antiquarians, and others. A fresh examination was made: and finally the decision of the "three mathematicians" was adopted, and their proposal accepted.

There was no time to be lost, and no time *was* lost. Before the end of that year, 1743, two girders were braced round the drum. In 1744, three more were added. According to Poleni, their weight amounted to 119,044 Roman pounds, or 39 tons.

In 1747 it was found that the "mathematicians" had conjectured rightly, that the girder put in under Sixtus V. had sprung; and another was substituted for it. These iron circles are not visible, but are imbedded in the stonework.

We have here a notable instance of science coming to the succor, or rather to the rescue, of art, in one, certainly, of its most painful crises. One knows not which most to admire; the sagacity which at once recognized the power that was needed and called it in, or the free and unlimited scope given to its exercise, or the sensible acquiescence of the artistic commissioners, or the sound judgment of the scientific deputation, or, finally, the complete success of its remedy.

Without this all else, and a vast expense, would have been wasted. But the proposed cure fully answered; and now, after 120 years, no sign has been given of subsequent damage; but the seals, or dovetails, placed over the former fissures, left purposely open, are unbroken and unmoved.—London *Architect.*

## The Establishment of Old Lot Lines and the Adjustment of Discrepancies.

Written for ENGINEERING NEWS.

BY S. WILLET HOAG, JR., ASST. ENG. DEPT. OF PUBLIC PARKS, N. Y.

(*Concluded from page 291.*)

Fig. 2 (scale exaggerated in details for purposes of illustration) represents the final fixtures for the block corresponding to Fig. 1. A reference to these diagrams will show a difference between the correct and the deed frontage of lot 46 a, on Washington Avenue, of 1.5 feet. This lot is described as lying on the west side of Washington Avenue, 382 feet south of the S. W. corner of Fitch Street, and running thence southerly along the said west side of Washington Avenue, 50 feet more or less to the northern boundary of the village of Central Morrisania, thence westerly, etc. Lot 108, Fig. 1, is described as lying on the west side of Washington Avenue, 100 feet north of the northwest corner of Twelfth street, and running thence northerly along the said west line of Washington Avenue 107 feet 6 inches, thence westerly, etc. The several frontages having been examined and verified, with the exception of lot 46a, are left intact by right of deed and priority of possession, and the latter is given the benefit of the 1.5 feet. Had it been a deficiency instead of a surplus, the same lot would have been obliged to suffer the loss of the discrepancy. A similar instance is presented in the case of lot 46c fronting on Railroad Avenue. Where a lot is described as running so many feet more or less to a certain line, the fixture of this line is of primary importance as a factor in localizing and determining the disposal of any subsequent discrepancy.

If, after establishing the old street lines, a block is found to be longer or shorter than is shown on the property map, and there are no subdivisions marked on the ground, the surplus or deficiency is distributed proportionately throughout the entire frontage. Cases of surplus are far more frequent than those of deficit. A deficiency is generally the result of carelessness and errors in the old surveys. A surplus is quite often the result of intent. Another explanation of these discrepancies is an old custom in farm surveying, of taking measurements along the ground, regardless of slope.

Here is a case (Fig. 3,) somewhat different from the preceding. The figures in parentheses represent the deed description. Plot 42 is described as beginning, say at the corner *a*, and running thence with the courses shown on the sketch, the last course reading, "and running thence N. 20° E. 233 feet more or less to the south line of ——'s property (No. 19). The latter lot is described as lying 37 feet south of, say corner *b*, and running thence S. 20° W., 61.5 feet, thence S. 70° E., etc. Investigation proved that there was a surplus in the two frontages of 0.71 feet, but the owner of lot 19, had built upon and occupied 67.71 feet front, which left but 227.5 feet instead of 233 feet as the length of the final course of No. 42. This case was actually contested in court and resulted in a victory for the owner of lot 19, so the dimensions now stand as recorded without parentheses.

In these calculations the rectangular system of coordinates is used. The results are carried to hundredths of a foot and angles to the nearest second. With the exception of obviously rectangular lots, some of the dimensions are necessarily the result of calculation, they being dependent upon, and fixed by others of the same plot or of adjoining ones. Hence, each separate parcel will accurately close. There is such a thing as finding on old property maps the dimensions of a piece of land "fixed" too much in advance. Hence, the necessity in the case of irregular shaped parcels, of a thorough overhauling. The area of each lot is computed by the "double area" method, except in very simple cases, thus imposing a valuable check on the work. The result is recorded in units and decimals,—to thousandths—of a city lot (25 × 100) or 2500 square feet.

It would fill a small-sized book to explain in detail the actual operations in the investigation of property comprised in some of the blocks that are frequently worked up. And space will hardly permit even an enumeration of the variety of cases that occur. But the most usual ones have been alluded to. The principle involved is the same in all. Truth is the object to be attained and the fairest result in justice to all interests.

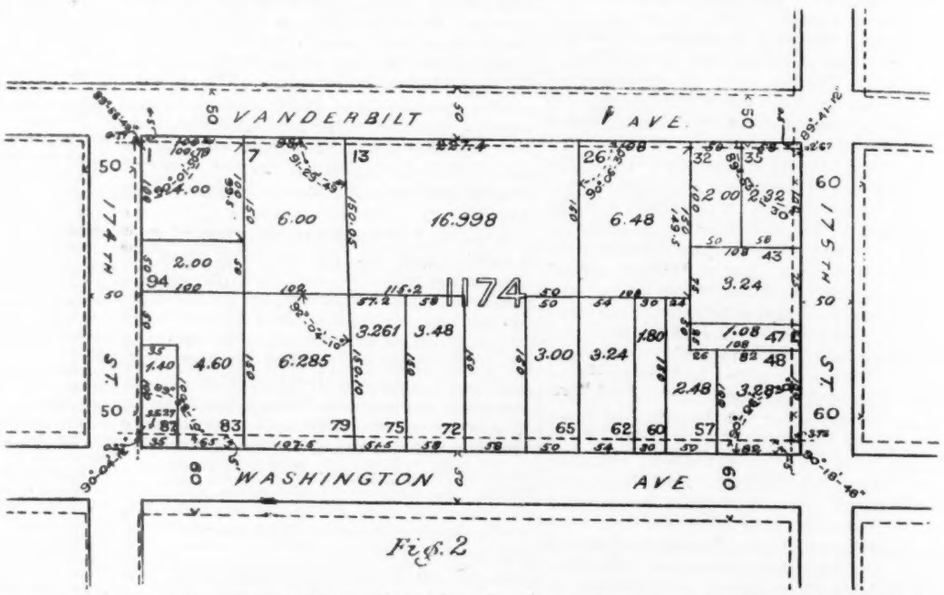



Fig. 2

Having fixed the property lines, the remainder of the work is purely mathematical though by no means free from complication. It consists in establishing a relation between the old blocks or parcels of property and the new street lines by a comparison of their relative locations,—a result readily determined by calculation, inasmuch as all surveys are referred to the monuments which mark the new street system. Where the difference between the old and new lines is small, making it improbable that legal proceedings will ever be initiated for acquiring right and title to the new street in behalf of the city, the dimensions of the end lots are shown *to* the new lines. But where, for instance, an existing street is to be widened or so altered in general alignment as to render legal proceedings positively necessary, these differences are given separately and the lot dimensions are shown according to their deeds. The main object of this is to simplify the future work on damage maps and assessments list. Both of these cases are shown in fig. 2, the dotted lines indicating the new street lines. Furthermore, where a plot lies in two new blocks thereby being converted into three parcels by the new street, the distances along the lot lines to the center lines of such street are recorded.

This portion of the work is more or less complicated as property is irregularly or uniformly cut up by the new street system; and it is especially so where the latter consists of curved lines,—the case with a large portion of the district.

(3.) DRAFTING.—In the progress of the calculations as each final result is obtained it is entered on a first draft or working sheet, drawn to scale (80 feet to an inch,) from which the finished maps are made on the same scale and on mounted papers 15"×24," the size of a page, showing old and new streets in their proper relations; their names and widths; dimensions, angles and numbers of new blocks; lot dimensions and areas, and lot numbers. Lots are numbered consecutively around the block, beginning at the lower left-hand corner, allowing or omitting in the numeration sufficient numbers for every 16 feet 8 inches of frontage where a lot is more than 25 feet wide. (Fig. 2.) This is done in order to provide with their appropriate numbers any future subdivisions. No plot receives more than one number, even though it may front on two streets.

The maps are bound in volumes averaging twenty-one pages each, and when completed will comprise nine volumes for the 23rd, and about fifteen for the 24th ward.

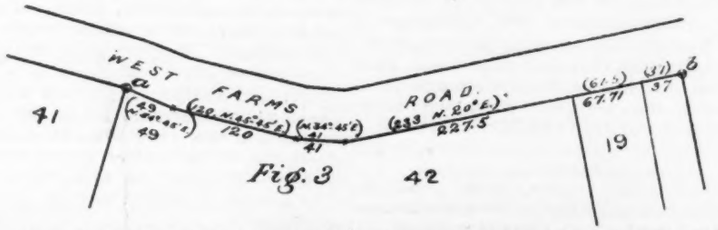



Fig. 3

The magnitude of the work may be realized from the fact that over sixty small villages formerly existed in the two wards, not to mention the large farms and estates lying outside of these villages. And it is estimated that there are over twenty thousand separate pieces of property representing as many ownerships. This estimate does not include the contiguous portions of subdivided property held by the same party.

The Tax Maps serve an important and legitimate purpose aside from their direct object. Their value to *city surveyors* can hardly be overestimated, for based as they

THE PUBLIC SUPPLY OF HYDRAULIC POWER:—PUMPAGE DIAGRAM.

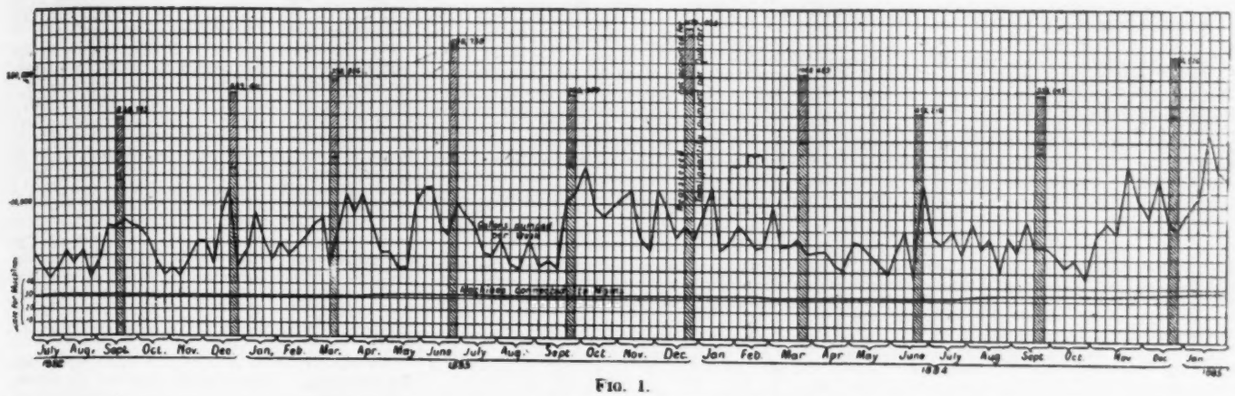

July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan Feb Mar Apr May June July Aug Sept. Oct Nov Dec Jan
1882
1883
1884
1885

FIG. 1.

are upon a new and complete system of street monuments, old lines can be readily retraced at any subsequent period.

It is useless to claim that in an examination of this character, conducted on so extensive a scale an injustice will not at times be committed; but a conclusion is never adopted until the person in charge is convinced that it is the best that can be done. And surely with the detail and elaborate information regarding the annexed district in the possession of the D. P. P., this cannot be considered presumptuous. The exceedingly rare instances of disputes amongst property owners using these maps as reference and authority, is the best evidence of their popular favor and consequently close approximation to truth and fairness. And where the date required for establishing a conclusion are so vague, incomplete and contradictory as they are in many cases, it will be readily seen that it requires the exercise of no little patience, technical skill and discriminating judgment before a decission can be safely recorded. This branch of the department work is at present under the supervision of Mr. H. W. Vogel.

## Recent Progress in the Public Supply of Hydraulic Power.*

BY MR. E. B. ELLINGTON.

It is now a little more than four years since I first brought before you the subject of the public supply of hydraulic power, when I gave a description of the works and operations of the Hull Hydraulic Power Company, which had then had four years' experience of actual work.

The Hull Works were of an unambitious character, but being the first of the kind in existence naturally attracted a good deal of attention. The growth of the undertaking was at first very slow, due partly to bad times and partly to the indisposition of the majority of the warehouse keepers and others to adopt the new system until they had had some experience of its workings.

Four years ago the Hull Company was just emerging from that condition of want of balance between revenue and expenditure, which is often so fatal to new undertakings, but there has been since an uninterrupted course of prosperity in all matters relating to the public supply of hydraulic power.

The introduction of a system of general power supply in the metropolis is necessarily a matter of considerable public interest and importance, and I thought it would not be amiss that I should so far allude to the part which the Liverpool Engineering Society has taken in the matter. In my previous paper I expressed a confident hope that before many years had elapsed an undertaking of this kind would be in operation in Liverpool, and it is particularly gratifying to me to be able to state this evening that, though the works have not been actually commenced in Liverpool, the necessary Parliamentary authority has been given with the concurrence of the Corporation, and the preliminaries are being arranged. It will, therefore, not be long before you will have an opportunity of studying on the spot the system, and of practically proving to your own satisfaction the advantages to be gained by the various applications of the power. This position of affairs is very largely due to the interest which Sir James Allport has taken in the question, and to the influential support he has given to the undertakings, both in London and Liverpool.

With regard to the progress in Hull, I am glad to say that the power continues to increase in favor with the various wharfingers and other users; no consumer, except from causes beyond his own control, has abandoned its use, and the great economy which has been claimed for the system has been fully established.

As to the maintenance of the service, it is a singular fact that since I last addressed you, four years ago there has been no repair in the mains needed, which have, moreover, been extended to supply additional buildings.

The diagram (Fig. 1) shows the quantity of power water pumped into the mains from July, 1882, to the present time, and also the amount registered in the meters, and it will be seen from this diagram that the power water not accounted for is less in the last quarter than in any previous quarters of which I have any record. During the four years there has been no consumer unsupplied with power when he required it.

I wish to call your attention to the very great variation in the quantity of power used in different weeks and quarters of the year—and the great variation in the same weeks and quarters of different years. A diagram such as this, not only gives the variations in the power, but is also a very good indicator of the varying trade of the port. I am glad to say that the last few returns I have are the largest on record, showing that the imports of grain and cereals forming the staple trade in Hull in the area served by the company are increasing, and that the fall in the line during the last three months was a temporary one, the pendulum now beginning to swing the other way. I do not see any limit at present to the development of the Hull undertaking, and you will easily understand that the experience gained by the working in Hull has been most valuable in dealing with the London works; many questions which would have been extremely difficult to have dealt with in an economical manner have been settled in London with a large measure of confidence in the success of the decisions taken.

The only novelty since my former paper in the application or the power in Hull is in its use for the extinction of fire. This is, however, one of the very greatest public importance, and it has been forced into prominence in Hull owing to the frequency of the fires in the wharves and mills alongside the Old Harbor. It would be generally supposed that the great head at which the power mains are charged (over 1600 feet) would enable the power water to be very effectua'ly used direct for fire extinction; but this is not by any means the case. To a certain limited extent it may be so used, but the quantity of water that can be spared from the power mains under ordinary conditions is too small to be of much service for any length of time, and, singularly enough, the pressure is too great. A hose pipe to stand 700 lbs. per square inch pressure is unmanageable, and the water is dissipated in fine spray at a very short distance from the nozzle.

What is wanted for a good jet is 150 gallons of water discharged per minute through a 1-inch nozzle. This through 200 feet of hose corresponds to a pressure of 150 feet head, or 65 lb. per square inch at the back of the hose. This condition is one that cannot practically be fulfilled by the power supply alone, and very rarely indeed by the ordinary domestic supply.

Mr. Greathead in conjunction with Mr. M. D. Martindale, has devised a very simple and perfect apparatus for combining these two services, and by so doing the deficiences of each are made good. The power supply gives over to the domestic supply part of its pressure, and its own volume; the domestic supply gives its volume to the power supply, and the whole forms one of the prettiest pieces of hydraulic apparatus I have ever seen. The injector hydrant, moreover, draws the water out of the domestic supply mains, and so makes up for possible deficiency in size.

Referring to the hydrant, on turning on the water from the ordinary main, say at a pressure of 60 feet head on a 3-inch branch pipe, it is delivered through 200 feet of hose at a nozzle at the rate of about 50 gallons a minute to a height of 10 feet. Turn off the ordinary water and open the inlet from the power main, and 40 gallons per minute are delivered to about the same height—a very feeble exhibition of power water at 700 lb. pressure. Now turn on the water from both supplies, and the result is most startling—a splendid jet of water of 150 gallons per minute is at once thrown to a height of 80 feet, and the pressure in the ordinary water main falls to 30 feet head, while the quantity of power water used is less than in the former experiments.

Mr. Greathead has read more than one paper on the subject of his hydrants, and I must refer you to the proceedings of the Institution of Mechanical Engineers and other published papers for fuller details. It will suffice to say that the efficiency of the apparatus under varying heads, size of nozzles, etc., has been very carefully worked out, and that the useful effect obtained is from 30 per cent. to 33 per cent. according to circumstances—the greatest efficiency being, of course, obtained where the initial head in the water main is greatest.

A committee of the Corporation of Hull having witnessed such an experiment as I have described determined to recommend this system to the town, and at the present time a number of these hydrants are being put down in the streets of Hull for public use as a supplement to the ordinary means provided for the extinction of fire. The power mains thus become a continuous fire-engine, and I cannot but believe that in this direction they are destined in London and elsewhere to render great public service.

It was only the other day I noticed in a Liverpool daily paper an allusion to the possible use of the power in connection with a fire that occurred at Members' Mansions, one of those monster buildings in Victoria street, Westminster, where, owing to the height, there was considerable difficulty in bringing pressure to bear. It may be that the London streets will be so provided in time, but in the City of London the water company has refused to allow these hydrants to be connected to its mains, for reasons which it carefully keeps to itself. Fortunately for you, you are not under the dominion of a water company in Liverpool.

*Hydraulic Power in London.*—I must now turn to London, and tell you what we have done there.

The chief portion of the mains between Blackfriars and London Bridges, on both sides of the River Thames, have been under pressure since November, 1883, and in a few weeks extensions as far west as Victoria Station will be completed. The main pumping station is on the south side of the river, and the two sides of the river are united by two mains carried across Southwark Bridge. There are four 6-inch mains carried from the pumping station at Blackfriars, two of them to serve the city, and two quite independent are for the service of the southern district. All these mains are in communication with the two accumulators at the pumping station, and at present these are the only accumulators in use.

Each pair of mains is laid in circuit. There are main stop valves on the line about every 400 yards, so that any particular length of 400 yards of main can be isolated without interfering with the supply over the rest of the system. This is a most important matter when repairs have to be effected. By getting down to the defective joint and taking out one pipe a temporary repair can be effected in two or three hours, and a new pipe inserted during the night, after working hours.

We have so far had very few failures, but the few we have had have shown that a bad pipe can be removed and a new one inserted in from six to eight hours according to the character of the paving.

In laying long lengths of mains of this character with bolted flanges and subject to the large number o

*Paper read before the Liverpool Engineering Society.

irregular bends and deviations required to avoid obstructions in the line of main, it is a very difficult matter to avoid undue straining of the flanges in bolting up, and what failures in pipes we have had, have been either due to initial strains of this character or to settlements in the ground. The mains will, however, stand a considerable amount of settlement without any further result than a slight leakage. There was a curious instance of this in the autumn of last year. The Metropolitan Inner Circle Completion Railway was nearly finished, and it was found that water was getting into the tunnel. The water mains were examined but nothing appeared to come from them, when it was suggested that it might be from our mains. We were aware that there was a leak in our main somewhere, and were about to localise it when the intimation reached us. On examining the pipe, which was laid in made ground, we found that a quantity of ballast had sunk and left the pipe unsupported at the joint and the pipe in sinking had allowed the joint to open sufficiently to create a leakage, but without any break, notwithstanding that this joint had been so tightly made that there was no escape at a pressure of 1000 lbs. on a square inch. This instance serves to show that there is a considerable amount of flexibility in these hydraulic mains.

While on the subject of leakages I may mention one or two other curious experiences we have had during the past eighteen months.

In one place on the main, in Carter-lane in the city, we found a slight leakage was going on, and, on examination, a fine stream of water was seen coming from a joint. When the pipe was removed it was seen that the spigot of the joint had a fine slot in it about ¾ inch long and 1/16nd wide. This joint had been quite tight under the test pressure which had been applied twelve months before, and the slot was not then existent. Its presence is to be accounted for by a very slight flaw in the metal through which the pressure finally forced its way, and having effected a passage, like a nibbling mouse, had industriously proceeded to enlarge it, until the volume escaping directed attention to the circumstance and its further ravages were promptly checked.

Another curious instance of a leakage occurring was in Holland-street, Southwark. This leakage commenced suddenly and came at once through the paving, and it was assumed that a pipe had broken. However, this was not the case—the pipe, on being removed, being perfectly sound and good. The cause of the leak was that the gutta-percha ring that forms the jointing material had been a little too large in diameter, and had not fitted perfectly in the recess, and the excess of length in the gutta-percha ring had bulged into the pipe and formed a loop. This joint was in the first length of main laid in London. It was made in February, 1883. It passed the test of 1,000 lbs. without leaks and continued under pressure until November, 1884, quite tight, when one morning, without any apparent cause, it suddenly developed a leak of sufficient amount to force up the pavement. The gutta-percha ring was intact as first put in.

I have been, on more than one occasion, rather severely taken to task by the makers of the pipes for subjecting every pipe to a such a high test as 25,000 lbs. per square inch (the thickness of the 6-inch pipe being 1⅛ in.), and further requiring that this test shall be applied for some time without any sweating. Such an experience as that in Carter-lane which I have just related (and I could name some others of somewhat similar character) is a proof that such tests are absolutely necessary to insure a successful installation.

A diagram of the water pumped into the mains of he London company shows, in October, a very marked rise in the delivery, followed by a rapid fall. That rise was almost exclusively due to the two small leaks on Cannon street and Carter lane, and I cannot state any fact that will more conclusively show that the absolute integrity of the main is the most important factor in the successful working of a Hydraulic Power Supply Company. This being so, no consideration, within the limits of what is practically possible, should stand in the way of obtaining what is desired.

We may, I think, congratulate ourselves, considering the small experience available as to the behavior of hydraulic power mains in crowded streets, on the results obtained in London, for with eight miles under pressure during nine months of last year, the first working year of supply, we had no failure. I attribute this success largely to the assistance I have had in carrying out these works from my colleague, Mr. Corbet Woodall, who has had so large an experience in gas supply, and also to the care exercised by our chief assistant engineer, Mr. G. Cochrane, now the company's superintendent.

All the hydraulic pipes I have seen broken, whether under test with flanges bolted on, or in the main as laid, have parted at the flange (see Fig. 3)

It seemed to me that even though breakages were of very rare occurrence, it would, nevertheless, be desirable to strengthen, if possible, this weak place. The most obvious way was to thicken the flange, but this was already too thick, as shown by the fact that in the flanges broken, the metal in the thickest part of the flange was generally faulty, due, as is well known, to the difficulty of getting perfectly sound castings with sudden and large variations of section.

I was led, therefore, to design the new form of joint shown in Fig. 3, putting a considerable projection on the pipe beyond the flange, the spigot and faucet being formed on this projection. The practical effect of this is to increase the depth of the flange without increase of its section at the junction with the pipe. I had a number of similar pipes, with the old and improved flanges, made and tested to destruction with flanges bolted on, and the mean of twelve experiments gave the following result: With old form of flange, breaking strain 3300 lbs per square inch with new flange 5030 lbs, per square inch; increase of ultimate strength of the new flange 52 per cent.

In all the larger sizes of pipes, we have, on the strength of these results, adopted the new form.

The main valves used are of the balanced type of lift valve, with a waterway the full area of the pipe. The balancing is accomplished by the insertion of a small

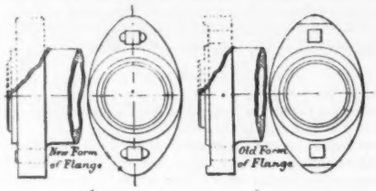



Fig. 3. Fig. 2.

controlling valve 1½ inch in diameter inside the large valve, the only work to be done by the turncock, being the raising of the small valve and the dead weight of the main valve. By this means a 6-inch valve which is pressed upon its seat with a pressure of 28 square inches × 700 lbs. = 8.8 tons, can be manipulated with ease with one hand on a 12-inch lever. The chief novelty in the arrangement is the method by which the valve remains balanced on whichever side of the valve the pressure is admitted. This is an important considerations when the valve has to be used on a circuit main with the water sometimes flowing in one direction, and sometimes in the other.

The engines† used at the main pumping station possess several points of novelty. The considerations which influenced me in their design were primarily the use of three throw pumps. 2. Direct connection between the pump plungers and the piston, 3. The compound principle in the steam cylinders. 4. The facility for starting. 5. The saving of space occupied. The center cylinder is high pressure, 19 inch in diameter, 2 feet stroke, the two outer cylinders, low pressure, are 25 inch in diameter, the pump plungers are 5 inch in diameter, and the quantity of water delivered into the accumulators under trial was 295 gallons per minute The work stipulated for was 140,000 gallons in ten hours the actual quantity pumped being 156,480 gallons, or an average of 260 gallons per minute.

The engines are fitted with surface condensers and air and circulating pumps, the condensing water being obtained from and returned to the reservoir tank forming the roof of the engine-house. The automatic starting gear for the engines consists of a bye-pass valve admitting steam direct to the low-pressure cylinder. This valve is opened by the accumulator on its commencing to fall, through the medium of a small hydraulic ram connected to the steam valve. As soon as the engine begins to move, it pumps a small quantity of water into this hydraulic cylinder, reversing the motion, and closing the valve. These engines will stop and start in any position, make a single revolution, and stop again.*

I do not know any type of engine which so well fulfils the conditions required in a hydraulic pumping engine, where space is valuable and coal expensive. The advantages are no doubt gained at the cost of some additional complication of parts and increase of first outlay over older types, but the use of a three-throw pump when working at such pressures as 700 lb. on the square inch, is an immense advantage. Compare the piston and plunger pump (the usual form of pump for hydraulic power purposes) to deliver the same quantity. There are the same number of pump valves in each case, but the suction valves are 6½ inch in diameter in the piston and plunger, and only 5 inch in the three-throw pump. The water in the suction pipe to the two pumps has to be stopped twice in the revolution; in the three-throw pump there is a continuous flow, and altogether the vertical three-cylinder and three-throw pump combination gives a better balanced engine and flow of water than can be obtained on any other system with which I am acquainted.

The indicated horse-power of the engines in London gave a maximum of 205 horse-power and 84 per cent. of efficiency in water pumped, the consumption of small coal in Lancashire boilers, with Vicars' stokers, being 2.4 lb. per indicated horse-power, and the weight of steam 20.7 lb. per indicated horse-power. The temperature of the condensing water at the end of the run was 98 deg. The delivery of the pumps was measured from the tank reservoir for one hour, and for the remainder of the ten hours' run the water was passed back to the tank after being pumped into the accumulators. The boiler pressure used is 80 lb. per square inch.

The accumulators are two in number, 20 inch in diameter, 23 feet in stroke, loaded to 750 lb. per square inch, and the general condition of the eight miles of mains and valves, and the valves and machinery worked from the power supply on consumer's premises, is such that the pressure has been kept up through twelve hours on a Sunday with only 290 revolutions of the engine, including in this the use of the power in the lifts in the Parcel Post Department of the General Post Office, and by every other consumer who may have ussd the power during the time. At an earlier period of the undertaking, with six miles under pressure, the accumulator has been known to remain up from Saturday night to Monday morning. A test of this kind, owing to existing conditions of working, is now impracticable, but it will often happen that there is hardly any perceptible motion in the accumulator for a few minutes at intervals with the engines standing.

The water used in the system is taken direct from the Thames at the station at Blackfriars. As you can well understand, the water in this condition is quite unsuitable even for water supply, and it was a grave question with us what method of purification we should adopt. In Hull the principal impurity of the water consists of a fine soft alluvial mud, which, with the limited quantity required daily, has been easily dealt with by a settling tank and subsequent filtration through a bed or rather partition wall of course gravel. This method was inadmissible in London owing to the space that would have been required. We accordingly determined to adopt some system of mechanical filtration, and finally selected the "Thames," filters, in which sponge is used as the filtering material.

There are four distinct filters arranged in two pairs.* Each compartment has within it a movable diaphragm or perforated piston, fitted with a piston rod attached to a hydraulic piston above each pair of filters. A pressure of about 7 tons is maintained upon the hydraulic piston by the accumulator pressure, and sufficient sponge is inserted through suitable doors into the compartment until there is a layer of about 1 foot of compressed sponge 4 feet 6 inches in diameter. The water from the Thames is pumped by centrifugal pumps or a pulsometer into a tank, divided into compartments, over the engine-room, designed, when complete, to contain 100,000 gallons. The water to be filtered is drawn from either of the three compartments of this tank, and passes through the filters by gravity into a filtered water tank, of about equal capacity to the unfiltered tanks, also divided into compartments, fixed over the boilers, but 7 feet below the level of the unfiltered water tanks. After its passage through the sponge filters it passes through a small bed of vegetable charcoal, 18 feet by 12 feet 8 inches by 9 inches, which both brightens the water and stops any little impurities that may have passed through the sponge.

Two or three times in twenty-four hours it is necessary to clean the filters. To do this all that is required is to shut off the unfiltered water, and open a communication to the drain—the flow of water being then reversed, and the dirt washed out of the sponge. At the same time the hydraulic piston and diaphragm are set in motion, alternately compressing and releasing the sponge, the action being precisely the same as when cleansing a dirty sponge by hand. From time to time fresh sponge is added of a value of 28s per cwt., and so far the cost of maintenance has been trifling.

The chief objection to the system is that the efficiency of the apparatus depends very much on the care with which it is worked by the attendant. The quantity filtered by the four presses is 10,000 gallons per hour. The water after filtration is, of course, quite unsuitable for drinking, but is sufficiently pure for power supply.

The boilers are of the Lancashire type, fitted with Vicars' mechanical stokers, with self-feeding hoppers and Green's economiser, the stokers and economiser being driven by a small Brotherhood hydraulic engine bolted to the boiler-house wall. We have found that this method of driving is both convenient and economical, for the speed of the whole apparatus is varied by opening or closing the stop-cock of the engine, and the hydraulic engine will run equally well at two or three or fifty revolutions a minute. Less coal is burnt when the hydraulic engine is at work than when the gear is driven from the donkey engine. I should add that in addition to the stokers and economiser, the little hydraulic engine with 3 inch cylinders and 3 inch stroke also drives a lathe in the repairing shop.

At the pumping station at Falcon Wharf, therefore, there are two novel and successful applications of hydraulic power, the direct-acting combined engines and presses (as I may call them) for the filters, and the hydraulic stoker gear.

On the quay outside the boiler-house is a double power movable crane, used for landing and storing pipes, etc., from barges. This crane has a novel arrangement of double power. One valve and lever controls both powers, and there is only one moving ram and no piston. The cylinder and rams are arranged

†See Engineering vol. xxxviii, page 101.

*The engines were constructed by the Hydraulic Engineering Company, at Chester.—E. B. E.

†See *Engineering*, vol. xxxvii, page 331.

like the upper portion of the balance cylinders in my hydraulic balance lifts.

There are some interesting historical associations connected with Falcon Wharf. There is an old house on the site, supposed to be some 200 years old, which has been renovated by the company, and is now occupied for its offices. This house is stated to have been the residence of Sir Christopher Wren during the construction of St. Paul's, of which a very fine view can be obtained from the top of the new accumulator tower. Before Sir Christopher Wren's time Falcon Wharf was the site of the "Falcon Inn," in the neighborhood of the Old Globe Theatre, of Shakespear's time, and the great bard is supposed to have had many a frolic where the pumping engines now stand.

Blackfriars is not the only pumping station for the hydraulic power supply. There is a small supplementary station in the neighborhood of Wood-street, in the City, and about two miles along the line of main from Falcon Wharf.

In the City, the land is so enormously valuable that it is necessary to economise to the utmost the space occupied by machinery, and there is nothing of special interest in the machinery which is used at this station, excepting the fact that duplicate boilers, pumping engines of 40 horse-power, and an accumulator, 18 inch diameter of ram 20 feet stroke, with coal bunkers' tanks, etc., and a lift to the street level are all placed within a space of 29 feet by 15 feet, and all except the upper portion of the accumulator, is underground—the upper part of the building being let for business purposes.

This station was originaliy intended to serve as a center of supply to a number of large warehouses in the neighborhood, recently rebuilt after the great fire of two years ago. Owing to the Corporation of London, in the first instance, giving leave to the company to extend its mains in this direction, and, subsequently, to the extended powers granted to the company by Parliament during last year, no independent center of supply has been needed, and it now forms part of the general system.

There is another pumping station at Kensington, which is altogether a new departure. This station is placed on the estate now known as Kensington Court, but formerly famous as that white elephant, called Kensington House, erected by Baron Grant as his "hotel." The house has been pulled down, and on its site and the surrounding seven acres of ground some seventy private houses are being built; thirty of them are already about completed, and each is fitted with a hydraulic passenger ram lift in place of a back staircase.

These lifts will all be worked by the Hydraulic Power Company, from its special station on the estate, at a fixed charge to each tenant per annum, the amount varying according to the number in use, and the minimum being 16l. per annum. The charge includes the inspection and maintenance of the lifts.

The lifts are so arranged that any occupant of the house can use them without an attendent, they can be controlled from either inside or outside; the doors of the lifts are interlocked with the controlling gear, so that no door opening into the lift well can be opened until the lift is stopped at that door, and until the door is closed the lift cannot be worked; the lifts can be automatically stopped at any desired floor. At Kensington Court the water after being used is returned to the pumping station. The pressure used on the estate is 400 lb. per square inch.

*(To be Continued.)*

## Designs for Cast-Iron Work*

So many disturbing elements intervene between the conception of a design in cast-iron, and the completion of the work in the building, that we all have to allow what we call a factor of safety (aptly characterised by the late Alexander L. Holly, C. E., as a factor of ignorance) to cover these contingencies, varying from three, or one-third the breaking strain in very simple cases, where the quality of the castings can be depended upon, to five or even ten where the design is more intricate, or the liability to shrinkage strains, hidden defects in the castings, rough bearing surfaces or uncertain variations of the load are possible. Much can be done by designers of cast-iron work to reduce this factor of safety, and consequently the weight and cost of castings, by giving serious consideration to the many processes and changes of condition through which their designs pass on the road to the building. Foundrymen excercise great ingenuity in producing any design in iron that may be presented to them; still it is possible to design things that are totally impracticable in cast-iron, in which case the designer would probably be asked to modify his drawing, but when it is possible to carry out a design without change it is the almost universal practice to do so without comment and without recollection of the fact that the resulting castings may have very serious shrinkage strains or other defects, which would reduce the strength far below what the the designer expected.

For instance a column, say 16 feet long, 8 inches in diameter, ¾-inch metal, is sometimes designed with a heavy projecting base moulding near the bottom, say 12 or 14 inches in diameter, giving 3 inches or more thickness to the metal at that point, also having an extension of the shaft to pass down through a shell plinth or pedestal, while at the top there is a shell cap and then a shelf, say 12 by 24 inches for girders, made, possibly, 2½ or 3 inches thick, to insure strength without the use of brackets or ribs. This, like all other architectural work will be moulded in "green sand," which is moulding sand slightly dampened with water, and rammed solidly around the wood pattern, forming a mould strong enough to withstand the wash and pressure of molten iron running into the mould. When we consider that iron weighs four hundred and fifty pounds per cubic foot, while water only weighs sixty-two and one-half, an idea may be formed of the strength of mould necessary to stand the wash and pressure, which, in a mould 3 feet high from the bottom of the casting to the top of the gate, where the iron is poured in, is fourteen hundred and forty pounds per square foot, nearly three-quarters of a ton on each square foot of surface: consequently the sand must be firm.

Now, realize that the pattern for this 16-foot column is made 16 feet 2 inches long, to allow for shrinkage; also remember that when this shrinkage occurs something has got to give. The shaft of your column being only ¾ of an inch thick, will solidify and commence to shrink while the metal in your heavy base moulding and the shelf at the top is still fluid, and little metal will run out into the body of the column as it draws away in cooling, leaving a little vacancy or depression in the upper part of the shelf or base. Presently these heavy parts will become about the consistency of cheese, but the shaft of the column keeps on cooling and getting shorter. Now the situation becomes serious. The soft metal in the base and shaft is not solid enough to allow the column to draw them bodily through the sand mould, so they stay where they are and the column shrinks away, stretching out more of the soft metal after it, making a weak place or leaving a nice little crack to be filled up with putty before the column is painted, and in an extreme case pulling away so much that the head will drop off when the column is hoisted out of the mould. Then the foundryman looks wisely at the column and says, "Now I will fix you," and puts a fillet around below the shelf, or a bracket, which will cool quickly and help pull, chipping out the bracket when the column is cold. In case all these fail, he just lays in some cold pieces of pig-iron before closing the mould, and they cool the heavy places off rapidly and everything is lovely. This last makes the soundest job in the lot, as they all melt down together; still there is liable to be dirt on the surface, and shrinkage strains that would not be there if the designer had made his metal in the shelf only one and one-quarter or one and one-half times as thick as the shaft, put in some strengthening ribs or brackets, and had also made his whole base shell, except a small bead or fillet, thereby justifying a smaller factor of safety, and all parts to cool at the same time. Mullion columns are often designed with a heavy square face cored out, which stands in front of the wood frames, while a thin web runs back between the sash-weight boxes. This is an exceedingly hard shape to cast without shrinkage strains. The cored part in front only radiates heat from one side (the core being quickly heated through), while the webbed back runs away off towards the remote parts of the mould, giving off heat on both sides, and the extreme back edge radiates in all directions but one, thereby cooling much faster than the front part, so that when the back has attained its length for normal temperature the front is still red-hot, and much longer. When the front cools there results a strain, which gives this column all it can do to hang together until it gets into the building, without doing its full share of work after getting there. Moral: A good, liberal factor of safety, or a nice large rib of metal, round or square, on the back of the web to keep it from cooling too fast

The privilege of modifying the thickness of parts of castings to avoid shrinkage strains is one that a designer can safely give a foundryman, for it is always cheaper to make castings right than wrong, to commence with. Still, any foundryman can call to mind numerous instances in which he has received serious rebuffs when he has volunteered advice which he considered good to designers who did not care to hear it, consequently they are often backward about volunteering their opinions Unequal cooling and consequent crookedness of shell pilaster faces, frieze plates, and light ornamental work is usually corrected by the foundryman without asking the designer's permission, as it is utterly impossible to get light work straight without providing for equal and uniform cooling. But in the manufacture of thicker pieces and parts intended to sustain loads of any kind, the foundryman never makes changes or asks permission to change, if he can possibly execute the work as per drawings received. Generally speaking, a more intimate association between designers and executors of cast-iron would result in a great saving of metal and a reproduction of the factors of safety. Imperfect and unsound castings, owing to carelessness in the manufacturing, are much more rare than is generally supposed. Cold shuts from pouring the metal too cold, honeycombs, dirt, and scabs from soft or unclean moulds are quite rare, and never dangerous in the work of reputable foundries. Many more bad castings are made through an honest endeavour to carry out a design which is not positively the best things possible for the place, than from carelessness in the execution of the work.

Among the most noticeable indications of shrinkage strains in finished castings is crookedness. One side will be shorter, therby giving the whole piece a crook, or in the case of wide plates they sometimes appear with the center perfectly straight and both edges "loose," or apparently too long for the center. The same may be said of the thin back ribs sometimes put on mullion columns. This comes from the apparently long parts cooling first, so that when the heavier parts cool afterwards the light parts are left too long for their places, while the loss of strength incident to these causes is usually provided for by the enormous factors of safety used. Still, if designers would examine their castings carefully they would soon be able to design forms not liable to these defects, and reduce their factors of safety accordingly.

*From instructions by Mr. C. W. Trowbridge, in the Hand-Book of the Union Foundry and Pullman Car Works of Chicago,

## Improvements in the Manufacture of Cement.

The *Engineer* states that several patents with this object have been lately granted in England. Mr. R. Stone's improvement in the process of manufacture consists essentially in grinding the materials in a red-hot state, giving a better prepared material with less consumption of power. The burnt clinkers pass red-hot through steel crushing rolls of special construction, and thence to the grinding rollers, the bed-plate of which is made concave and adapted to the lower, roll, so that the crushed material after passing between the rollers is further ground between the lower roll and the bed-plate. Mr. F. W. Gerhard adds lime to certain impure silicates of alumina and iron, and claims to make cement from the rotch bat or bovin, and what is known as black lime in the Wolverhampton district. Mr. E. W. Harding claims the application of gaseous fuel, in kilns construction, to the burning of Portland cement, together with the utilization of the waste heat, for the carbonization of coal and the heating of the drying floors; also the mixing of a certain proportion of resin with the cement mixtures to assist the calcination. Messrs. R. W. Lesley and J. M. Willcox seek to mold cement powder into forms suitable for the kilns, as respects size, adaptability to free draught, and the like, while dispensing nearly, if not altogether, with the water ordinarily required to bring it to the pasty condition for this purpose. They compress the powdered materials, damped by heavy pressure between rollers having cells or cavities wherein the powder is molded into blocks of the requisite size. Messrs. J. W. Matteson, W. J. Chapman and T. G. Matteson seek to improve quality of the mixture of chalk, clay and water in cement making, technically known as slurry, and obtain at a particular stage of the manufacture a more complete admixture and homogeneity of the materials, with perfect disinteraration, and free from small particles of chalk hitherto met with in all known processes of manufactures. The apparatus consists of a rotary sieve or tempse, preferably of conical shape, revolving in a well provided with an exit pipe at one end.

STANDARD TIME IN WISCONSIN.—The Wisconsin legislature has passed a Bill enacting that the standard time of the State shall be the mean solar time of the 19th meridian west of Greenwich, usually known as Central time.

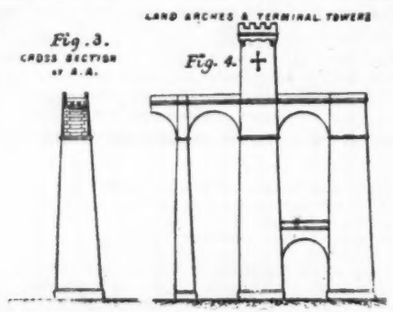
ENGINEERING NEWS Three months for One Dollar,

## Proposed Bridge over the St. Lawrence, near Quebec.

We are informed that the Canadian Government have sanctioned the proposal to construct a railway bridge across the St. Lawrence within a few miles of Quebec. It has long been recognized that a railway communication across the river at this point would be of incalculable benefit, and that the junction of the railway systems on opposite sides of the river would effect a great change in the inland communications and transport of the whole country.

The engineering difficulties which have to be surmounted are undoubtedly great; the width of the central or main opening cannot be reduced to less than about 1440 feet, while the channel which has thus to be crossed is, in summer time, the highway for the largest ocean steamers, and on the breaking up of the ice after the season, this narrow gorge is the scene of a tremendous "choke," the great masses of ice brought down from the wide reaches and lakes above, becoming concentrated in this narrow exit in such a way that they frequently pile themselves up to a height of 50 feet.

But with the resources which are now at the command of the engineer, and especially in view of the greater facilities afforded to bridge building by modern improvements in steel




manufacture, there appears to be no reason why these difficulties should not be successfully overcome.

The engineers of the proposed bridge are Mr. James Brunlees and Mr. A. Luders Light, with whom Mr. T. Claxton Fidler is associated as joint assistant engineer.*

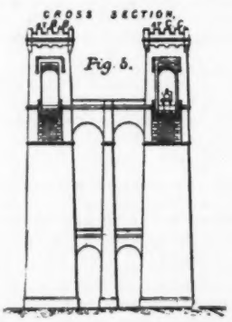
*Site.*—At the point selected for the site of the bridge, the River St. Lawrence narrows like a bottle-neck to a width of 2390 feet at high water; and of this space a great width of shore on each side is either dry at low water, or shelves only to a moderate depth; but for a width of about 1,400 feet the bottom shelves rapidly into deep water, and in the center the channel attains a depth of nearly 200 feet. The foundation is of rock and the piers of the channel span have been located at the farthest points consistent with due facility in executing the water foundations; and at their inner edges will stand in a depth of about 24 feet of water at low water.

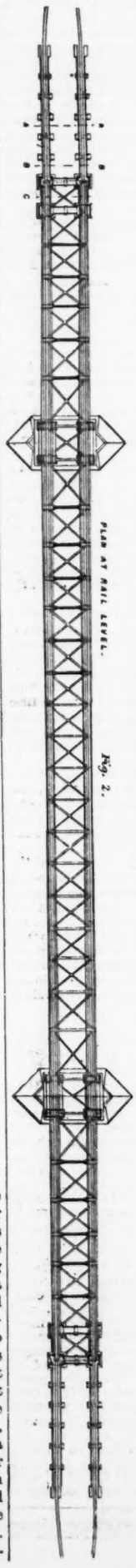
*Ice Choke.*—To provide against the drift of ice the two piers are constructed with massive masonry ice-breakers rising to a height of 60 feet on the upstream face of each pier. The total area of waterway at high water is at present about 200,000 square feet, and of this quantity not more than 4½ per cent. will be obstructed by the proposed piers. At low water the area of waterway is about 160,000 square feet, and the obstruction of the piers is not more than 2½ per cent.

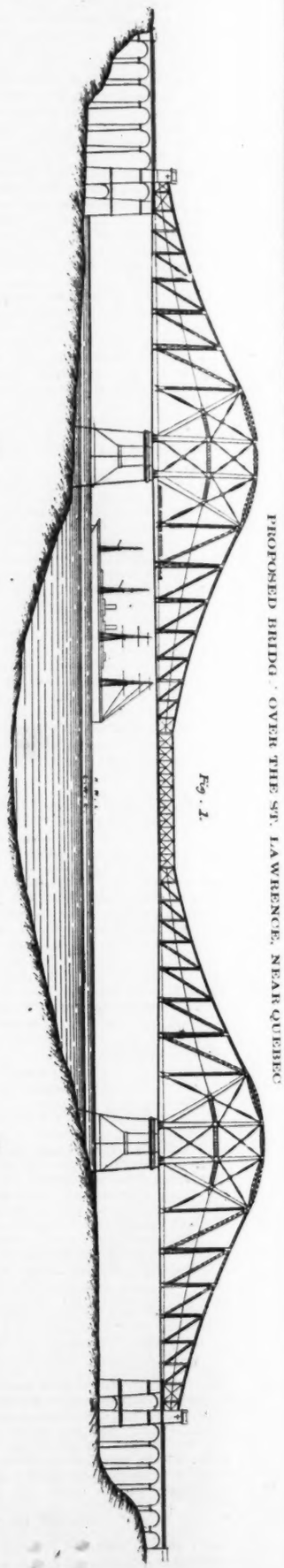
*Construction.*—The proposed bridge will consist of three principal spans, in addition to several land arches, which form an approach to the bridge from the high ground on each side of the valley. The central or "channel" span, will have a clear width of 1442 feet, the underside of the superstructure being carried across this span at a nearly uniform height of 150 feet above high water. The bridge is designed upon the cantilever principle and will be constructed entirely of steel. The total length of the steel superstructure is 2,800 feet, consisting of two main cantilevers and a short lattice span carried between them. The cantilevers are formed with the lower member horizontal, and the upper or tension member rising in two perabolic or nearly parabolic curves from each end towards the pier, at which point the cantilever attains its maximum depth of 258 feet. By this curvature the upper tension member takes up the greater part of the shearing stress, and the tall pillars of the web-bracing are subjected only to a very moderate compressive strain.

At the pier the load is brought down upon the bearing point in four converging lines—or in other words the reaction or supporting force of the pier is distributed by four great steel struts or pillars radiating from the top of the pier like the spokes of a wheel segment, of which the upper member forms the rim; so that over the pier the upper member is curved in a reverse curve or polygon tangenting with the concave or sagging curve which extends to each end of the cantilever. The effect of this reverse curvature of the upper member, is first to relieve the tall slender pillars of the web-bracing, and then to distribute the great shearing stress at the piers equally between all the four great radiating struts or pillars. The land end of each cantilever is anchored vertically down to a masonry tower—or rather a group of four towers united by arches. The anchorage, which has to counterbalance the weight of the lattice span and of the central rolling load, is effected at the extreme end of the cantilever; but the girders take a bearing first upon the inner pair of towers. One of the objects of this arrangement is to establish a positive bending moment over the inner towers, in order to present the insistence of a compressive stress which would otherwise take place in the upper members under a certain unequal distribution of the rolling load.

*Wind.*—Having now described the general elevation of the bridge and the action of the load in the vertical plane, it becomes necessary to refer now to the cubic form of the structure, and the action of the horizontal or wind forces, which in this case are quite as important as the vertical forces. The whole superstructure may be described as consisting of two single-line railway bridges spaced at a lateral distance of 90 feet center to center and braced together; and here it may be mentioned that in like manner the approaches to the bridge consist of two single-line viaducts in parallel lines 90 feet apart, each viaduct being formed of six masonry arches of 40 feet span, and 150 feet high, terminating in the group of towers before referred to. Reverting, however, to the wind strains, the bridge, as a wind girder, will constitute, not a cantilever bridge, but a continuous girder bridge with only one fixed point of contrary flexure; it will be, of course, a bridge of three spans, and the wind girder will have a uniform depth (i. e. breadth of floor) of 90 feet from center to cen-




* In order to give a more readily appreciable idea of the scale, the Orient steamer Austral, 455 feet in length, is drawn to scale under the central span in the general elevation.

ter of flanges, or about 108 feet over all. And it is intended that the severance of the flanges of the wind girder, which is necessary to provide for expansion, shall be located as nearly as practicable at one of the natural points of contrary flexure of that continuous girder. This arrangement has been dictated by a careful consideration of the questions involved in the deflection of the wind girder as offering the most solid and substantial construction, as regards wind forces, which it is possible to adopt. The plane of the main wind bracing is at the level of the railway, the lower members of the cantilevers forming the flanges of the wind girder.

With regard, now, to the upper wind forces; in the first place the towers are of course rigidly braced in transverse and horizontal planes; then the upper members of each single-line cantilever are united by upper wind bracing, forming wind girders about 17 feet in depth, by which the forces are transferred to certain intermediate points of support, which are provided by the construction of transverse frames of bracing, by means of which the upper wind forces are transferred to the leeward cantilever, the canting moment of the upper wind forces being added to the load and provided for in the calculated strains and strength of each cantilever.

*Erection.*—The side spans of the bridge, being almost entirely dry at low water, it will be practicable to erect staging for the temporary support of the bridge at any required points between the river piers and the abutments. When the main towers have been erected, it will not be very difficult to carry a temporary wire cable across the whole span, which would have a clear width of 1240 feet across the central opening, and a versine of about 190 feet, following nearly the line of the upper member of the cantilever.

From this cable, or set of cables, temporary scaffolding may be suspended, which, of course, will not be required to carry the weight of the cantilevers, but will be of great assistance in the piecemeal construction of the individual members, the erection of the upper tension member from point to point, the building of the web pillars, and so on. The cantilever will of course carry its own weight as it is progressively built out, but the suspension cable will serve to support a scaffold from which the detailed operations may be more conveniently carried on. The lower member of the cantilever, being horizontal, it will be practicable to push forward the side girders, length by length, by the process of rolling forward. The wind bracing will be made good progressively with the construction of the cantilevers; and finally for the erection of the intermediate span, it will be open to the constructors to select from several alternative methods—either by overhead suspension making use of the temporary cables, by erection upon staging carried upon the ice in winter, or by rolling over from each side towards the center.

*Strength.*—The bridge is designed to carry the heaviest railway traffic covering the whole extent of both lines of railway; and in view of the exposed position of the bridge, a wind pressure of 56 lb. per square foot has been provided for. The greatest stress in any of the steel members of the bridge will be 7½ tons per square inch of sectional area, which is reduced in long struts, and in the members of the wind bracing exposed to alternating strains in opposite directions; in the latter case the stress is generally not more than 5 tons per square inch.—London *Engineering*, April 3rd.

A FRENCH company of engineers have contracted to build a breakwater in the harbor of Vera Cruz, to cost $10,000,000, and the Government is in treaty for the construction of several lighthouses on the coast.

## The Theory and Calculation of Earthwork Slopes.*

written for ENGINEERING NEWS.

BY MANSFIELD MERRIMAN, M. AM. SOC. C. E.
Prof of Civil Engineering at Lehigh University.

*Concluded from Page 295.*

17. PRACTICAL CONSIDERATIONS.—The degree of moisture of earth exercises so great an influence upon its specific gravity and angle of repose that special pains should be taken to ascertain the values of those quantities which are the most unfavorable to stability. In general a high degree of moisture increases $w$ and decreases $\varphi$. These causes alone would tend to increase the cohesion, but at such times $H$ usually becomes so small that $c$ is greatly diminished. The determination of $H$ is awkward and there seem to be few recorded experiments concerning it. Care should be taken that the trench is long, or that transverse cuts be made at its levels as that lateral cohesion may not prevent rupture, and a considerable time should be allowed to elapse so that the cohesion may be subject to unfavorable weather.

The general conclusions of the preceding theory are valuable, but it should be applied with caution to particular cases, not only on account of the variability in the data but on account of our ignorance of the proper factor of security. Numerical computations however may often prove useful as guides in assisting the judgement. As shown in Art 16 a great saving in the cost of moving material will result if slopes be built in accordance with the theory, but evidently the cost of properly protecting the slopes will be increased. Should the latter cost prove to be the smaller the theory will ultimately become of real practical value.

18. LITERATURE OF THE SUBJECT.—The preceeding theory is not new, having long since been set forth in many French and German books, but the author is unaware to what extent it is practically used in those countries. The introduction of a factor of security is however believed to be new, and by proper experiments for determining its value the practical application of the theory will be rendered possible. The following works treat of the subject:

Navier, Leçons sur mécanique, Paris 1833.

Collin. Recherches sur les glissemes des terrains, Paris 1846.

Becker, Baukunde des Ingeniurs, Stuttgart, 1865.

Winkler, Vorträge über Eisenbahnbau, Prag, 1876.

Von Ott, Vortrage über Baumechanik, Prag, 1877.

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## When Brick Walls Were Strong.

In 1856, when the old Brick Church at Beekman and Nassau streets was pulled down, the workmen encountered brick walls very different from those of Contractor Buddensiek. The old church made a sturdy resistance to its destroyers. The roof was taken off and the windows were removed without much trouble, but the walls, built of the old thin brick and cemented with shell lime mortar, flatly, or rather perpendicularly, refused to be moved. Heavy cables and windlasses were used, but the cable snapped asunder and the walls stood. At last a deep groove was chiselled on the inside of each wall its entire length, and a heavy chain was passed around the center of each side wall through the window opening, and so fixed in the center of the church that when the strain came the walls would be drawn inward. One end of the chain was then passed out into the City Hall Park, where it was wound round great slanting posts imbedded in the ground. Gradually the chain was drawn tighter and tighter, until the pressure was too much for the resisting walls, and they caved in. But that was only the beginning. The men were employed for weeks in breaking down the pieces of the walls still standing. Stubborn to the last, the fragments refused to be separated into single bricks, and were carted away in large pieces.

The tower remained standing last of all, the wooden steeple having been taken away. The tower was about sixty feet high, built of brick, with a stone foundation. This was even more obstinate than the walls had been. At last the workmen cut out a piece of the foundation five feet in depth, from the rear to the front wall, putting in huge blocks of wood as fast as the work proceeded, in place of the foundation taken out. The plan was to pull out the wood, and so let the tower fall. Various contrivances to get the wood out failed. It was finally determined to burn it out. Great charcoal fires were built for the purpose, and the people in the Tract House, Banks & Brothers' store, and Savery's Hotel watched the incineration with patient interest for several days. One evening just after six o'clock, the earth and the neighboring buildings were suddenly shaken. There was a roaring crash, and clouds of dust darkened the neighborhood. The tower had fallen, the fire having eaten the wood out from beneath it.

There still remained standing the front wall of the foundation. Men were set at work to undermine it, and while thus engaged the ponderous mass of masonry fell upon two of them. For a minute it was supposed that they had been crushed to death. Soon one, and then the other, crawled out. In falling the wall had split in the center, and when the two pieces struck the ground, unyielding to the last, they formed a sort of arch, from which the stunned workmen emerged, bruised and blackened with dirt, but not seriously hurt. —N. Y. *Sun*, April 20th.

## Brickwork.

PROFESSOR RANKINE.

The following principles are to be observed in building with bricks: (1) To reject all misshapen and unsound bricks. (2) To place the beds of the courses perpendicular, or as nearly perpendicular as possible to the direction of the pressure which they have to bear, and to make the bricks on each course break joint with those of the courses above and below by overlapping to the extent of from one-quarter to one-half the length of a brick. (3) To cleanse the surface of each brick, and to wet it thoroughly before laying it, in order that it may not absorb the moisture of the mortar too rapidly. (4) To fill every joint thoroughly with mortar, taking care at the same time that the thickness of mortar shall not exceed about a quarter of an inch. In order to prevent the use of too great a thickness of mortar, it is usual in specifications to prescribe a certain depth, which a certain number of bricks shall not exceed. For example, if the bricks are 2¾ inches deep, it may be specified that four courses of bricks, when built, shall not measure more than 1 foot in depth, a condition which implies that the average thickness of mortar in the joints shall be ¼ inch. (5) To use no bats or pieces of bricks, except when absolutely necessary, in order to make a "closure," that is, to finish the end or corner of a wall, or the side of an opening, and even then, to use no piece less than half a brick.

THE PROSPECTS of the completion of the Iowa, Sioux Falls & Northern railroad from the Burlington, Cedar Rapids & Northern road through Rock Rapids and Sioux Falls during the present season are very promising. The towns along the line on Tuesday voted the requisite bonds, and negotiations are being made at Cedar Rapids with the Burlington, Cedar Rapids & Northern company to build and equip the road before Jan. 1st next.

PROPOSED BRIDGE OVER THE ST. LAWRENCE, NEAR QUEBEC

# Engineering News

AND

## AMERICAN CONTRACT JOURNAL.

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WE would call attention to the fact that the date for the receipt of proposals for the building of water-works at Lansing, Michegan has been extended to May 25th, at 4 P. M.

THE annual dinner of the Institution of Civil Engineers was held in London on April 29, in the conservatory of the Royal Horticultural Society, South Kensington. About 500 gentlemen were present, including an unusual number of guests attracted to the city by the opening of the Inventions Exhibition. Speeches were made by Sir Lyon Playfair, Sir Henry Bessemer, Sir George Grove and Sir Frederick Bramwell, and also by the Duke of Edinburgh and the Duke of Cambridge.

*Le Genié Civile*, of Paris, offers a pocket revolver at a reduced price, as a premium to present and prospective subscribers to that journal for the present month.

This announcement is rather startling, coming as it does from the representative engineering newspaper of France; and smacks rather of the journalistic methods and public needs of Arkansas or the "Far South," than those of conservative Frenchmen. But as the press lately presents rather numerous instances of the potency of the revolver as a factor in the settlement of domestic and private difficulties in Paris, *Le Genie Civile*, with its usual enterprise, is doubtless ready to do its share in supplying the "long-felt want."

The article itself, as illustrated, is about as novel as the announcement. It is a 10-shot affair, and looks more like a blacking-box with a tube stuck into its periphery than a revolver. It is verily a "pocket-mitrailleuse," as the editor describes it.

### The London American Exhibition of 1886.

The opening of the proposed American Exhibition in London, has been fixed (D. V.) for May 1, 1886; and the *American Eagle*, the official journal of the Exhibition, reports very encouraging progress, and has published the "Regulations for Exhibitors."

According to these regulations, the charge for space will be 50 cents per square foot of floor or wall surface, the minimum charge for any space being $50; payment is to be made at the National Bank of Commerce, New York, within 30 days after allotment of space. Exhibitors will be required to erect at their own expense all counters, enclosures, etc., required; attend personally or by agent to the exhibition or sale of their goods and pay all transportation and installation expenses. Goods will be entered free of duty until sold. All goods must be delivered between March 1 and April 15, 1886. The Secretary of the American Exhibition, 7, Poultry, London, E. C., will give any further information required.

The whole scheme is certainly a novel departure in the exhibition world, but the material is at hand to make it a grand commercial success for Americans, and an attractive and profitable display for the nations of Europe as well. If carried out on the plan now contemplated it means the bringing of a New World to the doors of the Old, and constitutes a bit of object teaching that would be beyond compare for the variety and value of the lessons imparted. Its managers are live and experienced men; the form the exhibition is to take should be very popular, and popularity in this case means success.

### The London Inventions Exhibition.

London *Engineering*, for May 1st, is worthy of especial note for its bulk and the excellent and complete manner in which it has commenced the illustration and description of the exhibits of the Inventions Exhibition opened on May 4.

This exhibition already promises to more than rival its very successful predecessors, the Fisheries and Health Exhibitions, in the interesting nature of its exhibits and its popularity. As might be expected, electric lighting is made one of the leading features, and twenty-five or thirty firms are represented, among them all the well-known American companies.

The present Exhibition is as comprehensive in the nature of its display as its official title would suggest; and as "inventions" enter into almost every item of our daily lives, so the machines exhibited range in their applicability from those devoted to science, warfare and the higher grades of engineering down to the simpler but no less useful requirements of cookery.

The section devoted to the United States promises to be fairly well filled with representative exhibits, and will excell other countries than England, but it is to be regreted that the late Congress has provided no official commission for, or head, to what could be made one of the most interesting features of the Exhibition. As *Engineering* remarks, "inventive ingenuity is one of the especial attributes of the American people, and the present Exhibition cannot fail to suffer by the absence of official representatives from the United States Government."

Among the exhibits of Permanent Way, at the Inventions Exhibition is the Webb Steel Tie. This is the same in construction as shown in "Track," ENGINEERING NEWS, of Nov. 29, 1884; the description states that while the weight of a London & North-Western creosoted wooden tie, with its chairs, spikes, screwed spikes and felt liners, is 242 lbs., the Webb sleeper complete only weighs 174 lbs.; the weight of the latter being divided as follows:—tie, 9 feet long, 124 lbs.; two chairs, 28 lbs.; rivets, 5 lbs.; two lining plates, 15 lbs., and two oak keys, 2 lbs. The tie is said to be giving most satisfactory results in its use on the London & North-Western railway, where a large number of them are now laid.

The Holtnam Permanent Way, exhibited also, includes the ordinary English double-headed rail with a longitudinal sleeper of double-channel section, with a central rib forming a continuous rail-seat, and lateral ribs to which the chairs are attached. The jaws, or chairs, and the keys holding them, are made of cast-iron and the sleeper of mild steel or malleable iron. The cross-connections between the sleepers are T-irons riveted to the sleepers. So long as the ends of the cross-ties have an efficient bearing on the ballast it is claimed that neither spreading of the gauge nor tilting of the rails can occur. To provide for curves the longitudinal sleepers are cut at intervals, leaving narrow gaps on each side of the central continuous rib, which latter can then be sprung to fit the curve. For sharp curves, of say 10 chains radius, the gaps are made 6 feet apart with two pair of rail-jaws in each interval. With ordinary main-line curves, the gaps occur at 10 feet intervals with three intermediate sets of jaws. The weight per mile for a standard line, for steel sleepers and cross-ties is about 100 tons, and for cast-iron rail jaws and keys, 51 tons.

The Denham-Olpherts cast-iron plate sleeper is made in three different patterns; for the standard 4 feet 8½ inches, and the meter gauge of two styles. It is substantially a flat cast-iron plate, 2 feet 10 inches long by 10 inches wide and ¾ inches thick, the longest dimension being laid at right angles to the axis of the line. A rib of 1½ inches in depth projects from the bottom of the plate just under the rail; two stiffening ribs run the length of the plate on the upper side. The chairs for securing the rail are cast-iron for the double-head pattern; with the tee-rail, either a wooden cushion and bolts are used, or an iron plate and especial form of iron or steel clips over the foot of the rail. The weight and cost are not given; the cross-connection is an iron bar on edge, 2 inches by 1½ inches, passing under the rail and keyed by two keys to the top flanges of the chair-plate.

### Overhead Wires in London.

A committee of the House of Commons, of England, is to investigate the subject of overhead telegraph and telephone wires. At the first meeting of the committee, Mr. G. N. Johnson, Chairman of the London Commission of Sewers, testified that legislation was necessary for the control of wires, and he believed that it would be well to put them all underground as soon as it could be done without interfering with their practical working. The cost he admitted would be enormous of so disposing of them; and he believed that the telegraph should be separated from the telephone wires.

He stated that there were ten times more wires overhead in the City, than there were a few years ago, and they were so close together that serious damage might result from their fall, not an impossible thing during a heavy gale or severe snow storm.

Col. Heywood, engineer to the Commission of Sewers, reported, as showing the number of wires in place, that there were 320 over Moorgate St.; 312 over Coleman St.; 240 over Leadenhall St., and on Queen Victoria St., 8 cables and 408 wires. At one spot in Fleet St., at Ludgate Circus, he counted 2 cables and 142 wires; across King St., there were 6 cables and 74 wires, and over Cannon St., 7 cables and and 360 wires. Over some streets there were something like 1,200 to 1,500 lines to the mile. Col. Heywood thought that these wires had become a grave public nuisance, and that in

the near future it would be absolutely necessary to put them underground; but that the great expense of so doing should be divided between the local authorities and the public and private companies.

### The Paris Industrial Exhibition of 1885.

From July to November of the present year, an industrial exhibition is to be held in Paris under the patronage of the French Government. It will be held on the old-time ground, the Champs Elysées, and opens July 23rd.

The exhibition is open to all machinery and apparatus, moveable or stationary, connected with the arts and manufactures and products of industry and agriculture.

The charge for space is $10 per superficial *metre* of surface or frontage, as may be required; exhibits enter France free of duty and the accredited agent will lay the goods before the Jury and point out their merits; the cost of this representation is $60, which does not include expenses of freight or transport. A sum of 10 per cent. will be allowed to the Managers of the Exhibition on all goods sold in the interior of the main building. All payments are made in advance when making the written application for space to the Paris office as given below.

Léon Chotteau is the General Commissioner for the American Section, and Jacob H. Sommer, of 13 and 15 Laight Street, New York, can furnish further information concerning exhibits, blank forms, etc. The Paris office is 31 Boulevard Bonne-nouvelle.

### The Ordnance Survey of England.

From the last Report of the Ordnance Survey of England, now in its hundredth year of progress, we gather the following items: In 1841 the counties of Lancashire and Yorkshire were under survey on a scale of 6 inches to the mile; in 1855 this was raised to 25 inches to the mile for the general country, but important towns were plotted on a larger scale, some being 5 inches to the mile.

At the present time all towns of over 4,000 inhabitants are mapped to a scale of 10 feet to the mile. Maps of Scotland and Ireland are completed and published on the 6 inch scale. The total area surveyed last year was equal to 2,988,706 acres, and it is hoped that the entire work yet remaining to be done will be completed by 1890.

Accuracy is insured by having each portion separately surveyed by seven different surveyors, and it is said that the results attained will not vary more than a few inches in a distance of 500 miles. The two base lines upon which all primary triangulation has been founded, are; that on Salisbury Plain, 6.97 miles long, and measured in 1794 and again in 1849; and the base at Lough Foyle. The length of the latter, as ascertained in 1826, was 7.89 miles, and the length of this last line as determined by triangulation from the Salisbury base only differed from the actual measurement by 5 inches.

### Disposal of the Refuse of the City of Edinburgh.

The London *Sanitary World* of April 25th, contains the following abstract from the late report of Councillor Charles Robertson, on the disposal of the refuse of the City of Edinburgh, in conjunction with the utilization of sewage:

"He states that he could not agree with the report by the sub-committee, who recently visited various towns to inquire into the various modes adopted for the disposal of the sewage, and consequently he has issued this report. It begins by stating that in the four years from 1874-75 to 1877-78 the quantity of refuse to be disposed of in Edinburgh was 239,061 tons, while in the four years from 1880-81 to 1883-84 the quantity was 280,932 tons, or an annual average increase of 10,468 tons. The following statement shows the return of moneys obtained:—1874-75 to 1877-78, 23,537*l.* 10*s.* 2¾*d*; 1880-81 to 1883-84, 12,902*l.* 18*s.* 2½*d.* He refers to the system of burning the refuse, which, he says, costs about 1*s.* per ton. To adopt the method of cremation would simply mean the expenditure of 3,500*l.* to destroy what was at present yielding 3,300*l.*, and still have to deal with the residue, varying from 23,411 tons to 17,558 tons, left to be disposed of in the form of clinker. A calculation that has been made showed that Edinburgh threw into the sea valuable material amounting to 102,700*l.* annually.

"After referring to plans adopted in various towns, Councillor Robertson dwells specially on the charcoal system. He says:

"The power of charcoal to absorb noxious vapors may be realized from the statement by Mr. Danchell, C. E., 'that one cubic inch of charcoal will absorb 170 cubic inches of ammonia gas,' besides other matters (under favorable conditions). Dealing with this system in reference to Edinburgh, the circumstances are highly favorable to a successful issue. We have what is termed 'a pure sewage,' and our drainage system is so arranged that, instead of the huge volume of sewage other towns have to deal with at one outlet, we have four outlets, and consequently a smaller quantity at each. Sewerage-works would require to be established at four points to embrace the sewerage-system. The city would be divided into four sections for cleansing purposes, each section having a portion of the cleansing staff appointed thereto. From each section the refuse would be driven to the sewerage works or depot attached to said section. By that division of he city much expense would be saved in cartage.

"On arriving at the works the refuse would be tipped into a screen, which would retain portion number one. This portion would include some suitable matter for carbonisation. The rest would go to the destructor-boiler fires. The refuse which passes through the first screen would be received upon a second, which separates the small cinder from the fine ash. The small cinder would partly be used in the first filter-bed and partly in generating steam or heating the retorts, the fine ash forming a constituent part of the manure to be made. The destructor-boilers would generate the steam required for the machinery and drying purposes. The charcoal from the other filter-beds containing the bulk of the ammonia would be placed in the retorts, the ammonia extracted, and the charcoal used again and again, and finally disposed of in the manure. By this means a saving will be effected in the quantity of charcoal purchased or manufactured. As only a portion of the ammonia extracted would require to be incorporated in the manure, the remainder can be sold. It realizes a high price, and the revenue from that source must be considered in the question of cost.

"The sewerage-works would be entirely free from any odor. The treatment by charcoal deodorises the sludge, while in the drying process no offensive odors are allowed to escape. The clinker is thoroughly purified by fire. With regard to the question of cost, we can point out that an income would be derived from ammonia (highly valuable) and manure, besides smaller sums from solder, tin, old iron, etc. If the manure sold even at a few shillings per ton, taken with the other means of income, it is surely not too much to expect that the works would pay the expense, to say the least of it. At present the proposal is to sink, say, 40,000*l.* in drainage-works at Powburn, from which no return can be expected, not even that of interest for the money. Should this scheme prove practicable, that sum would go a long way in the purchase of plant and the erection of the filter-beds. The present market value of sulphate of ammonia (containing 24 per cent. of pure ammonia) is 11*l.* 15*s.* per ton. In Paris and other places in France the sewage is successfully treated in some such method as has been proposed, and the sulphate of ammonia obtained (containing 25 per cent of pure ammonia) sells at a correspondingly higher rate."

"In his conclusions Councillor Robertson says:—'The destruction of the refuse by fire would impose upon the town a large and increasing yearly burden. If no better method of disposal can be found, then the best method to adopt would be (1) To continue selling it as at present, until no further sales can be made; (2) then to give it away for nothing; and (3) to pay carriage on it to those who will take it, up to the extent of the cost of burning, before asking the town to erect works for destruction alone. All methods, except by charcoal, have failed to effect a profitable utilization of sewage. The system of filtration by charcoal, with the other processes indicated in connection with it, should be carefully and fully considered. — (1) Because many trustworthy opinions concur in its feasibility; (2) because the charcoal effects what other substances have failed to do; (3) because the effluent water is purified; (4) because there is a strong probability of success, and in the event of this, Powburn Drainage Bill might become a dead letter. As we do not advise the rash adoption of any scheme, however probable, until some test has been made, for the satisfaction of all concerned, we recommend that this act be remitted back with powers to expend from 50*l.* to 100*l.* in making an experiment to ascertain the value of the process and its probable cost."

### The Panama Canal.

The *Bulletin du Canal Interocèanique*, for May 1, gives the following as the progress of monthly cube extracted since December, 1884:

| | | |
|---|---|---|
| December, 1883, | 500,000 | cubic metres |
| January, 1885, | 550,000 | " " |
| February, " | 590,000 | " " |
| March, " | 627,000 | " " |

This statement is given as an answer to the charge that "for some months past there has been almost a complete stoppage of work on the Isthmus." The Anglo-Holland contractors are said to have finished the installation of their plant intended for operations upon the Culebra Cut.

The troubles at Colon and the burning of wharf property there have interfered with the landing of material; but on April 29, the Director General telegraphed that the new service was in working operation. On April 21, a dredge was reported as having passed the Mindi bar, in the canal and 4 Kilometers (about 2½ miles) above the entrance to the Canal on the Atlantic side, where it is now at work. This means that dredging is being carried on at three points in this section, at both extremities and in the middle.

### PERSONAL.

W. L. KING, has been appointed engineer and General Roadmaster of the Cincinnati & Eastern R. R. by Receiver McLean.

MAJOR J. M. Wilson, U. S. Engs., is to succeed Col. A. F. Rockwell in charge of public buildings and grounds in Washington., D.C.

MR. E. F. MANN has been appointed Assistant Superintendent of the Vermont division of the Boston & Lowell railroad.

CHARLES HOWARD has been appointed General Manager of the Worcester, Nashua and Rochester Road.

B. L. HARDING has resigned the position of vice-president and General Manager of the Wisconsin, Iowa & Nebraska railway.

W. R. WOODWARD has been appointed General Superintendent of the Louisville, New Albany and Chicago Railway, with office at Chicago, Ill.

ISAAC MINNIE has resigned his position as roadmaster of the western division of the New York Central & Hudson River road. Mr. Minnie had held this position for some twenty years.

EDWARD W. JORDAN, lately superintendent of the Buffalo division of the Rochester & Pittsburg road, will leave Buffalo shortly to accept a position on the Chicago, Milwaukee & St, Paul.

WILLIAM H. COOKE, said to have been at one time a wealthy civil engineer, but reduced through dissipation to beggary, blew his brains out at Pittsburg on May 7. Cooke was well connected, and a few years ago was worth $250,000.

C. W. SPENCER, has been appointed to the position of Assistant General Superintendent of the Eastern and Ontario division of the Canadian Pacific, with head office at Montreal.

A. A. GADDIS, during the past four years General Manager of the Ogdensburg & Lake Champlain railroad, has resigned, to accept the office of vice president and general manager of the Brunswick & Western road.

ARTHUR DANAHY, a well known railroad contractor, died at Elgin, Ill., last week. He had contracts at the time of his death near Seligman, Mo., on the Chicago & Alton, at Joliet, and had lately completed the Belt Line R. R. to Kansas City.

MR. G. BOUSCAREN, having retired from the position of chief engineer of the Cincinnati, New Orleans and Texas Pacific Railroad Company, will, on and from the 1st of May, be the consulting engineer of the associated companies, with the duties and perrogativse attaching to that position.

MR. G. B. NICHOLSON, is appointed engineer of the associated companies, and will be in charge of all construction and reconstruction work.

JOHN W. Nystrom, a well known civil engineer and author of Nystrom's Pocket-book and many papers upon engineering, died at his residence in Philadelphia on May, 10, aged 60 years. Mr. Nystrom was born in Sweden, but had been a resident of this country for many years. He was an especial expert in steam engineering.

Mr. W. W. COLLINS has been appointed Assistant Superintendent of the Chicago & Milwaukee Division and the Chicago & Council Bluffs Division in Illinois of the Chicago, Milwaukee & St. Paul Railway Company, with headquarters in Chicago. Mr. C. T. Kittredge has been appointed Train-Dispatcher of the Chicago Division.

PAUL BREMOND, President and builder of the Houston East and West Narrow-Gauge Railroad, died at the residence of Captain A. P. Lufkin, Galveston, Texas, on May 8th, of peritonitis, in his seventy-fifth year. The deceased was an old resident of the State, projector, contractor and first President of the Houston and Texas Central Railroad before the civil war. He sold out his interest several years ago, when he projected and built 198 miles of the Houston East and West Narrow-Gauge Railroad, not a single bond of which is on the market. He is the only Texan that ever projected and built a railroad out of his own private means. The deceased resided at Houston, where he leaves a wife and six children. He leaves a fortune estimated at $2,500,000.

COLONEL FREDERICK A. PETERSEN died at the hospital in Orange, N. J., last week. He was born in Prussia in 1808, and entered the army as a second lieutenant of engineers. He rose rapidly, and became a prominent advocate of the introduction into Prussia of the railroad system. It was his argument chiefly that overcame the objections of William IV to railroads. He continued for several years a great favorite at court. He took the side of the people in the revolts of 1848 and was arrested, but escaped from prison to America. He became a civil engineer and architect, and was the designer of Cooper Union. He has lived in Essex County for twenty years, and, although his acquaintance was large, his history was known only to a few.

## American Society of Civil Engineers.

ANNUAL CONVENTION OF 1885.

The Annual Convention of this Society for the year 1885 will be held at Deer Park, Md., on the line of the Baltimore and Ohio Railroad, June 24th, 25th, 26th and 27th, 1885. Sessions for professional discussion and one for the transaction of business will be held.

Members from the West may leave Cincinnati on Tuesday, June 23rd, at 8.50 A. M., arriving at Deer Park 11.24 P. M., or leave Cincinnati at 7.20 P. M., arriving at Deer Park, 7.30 A. M.

All members who can do so are invited to arrive at Baltimore on Monday, June 22nd, and take part in the excursion named below.

Train leaving New York (Pennsylvania R. R.) at 8 A. M., Philadelphia 10.16 A. M., arrives at Baltimore at 12.35 P. M.

By invitation of the officers of the Baltimore and Ohio Railroad Company, a steamer excursion will be made by members and their families on Monday afternoon, June 22nd, to the Water Front of the Harbor of Baltimore, the Marine Terminals of the B. and O. R. R., Locust Point, Canton, Fort Carroll, Fort McHenry and Curtis Bay, returning to Baltimore early in the evening.

Those who desire to visit the Water Works of Baltimore are invited to do so on Monday afternoon, leaving the hotel at the same time as the party for the steamer. Provision will be made for such visit, under the escort of R. K. Martin, Esq., Chief Engineer, Baltimore Water Works.

Members and their families are invited to visit the summer evening concert, at the Baltimore Academy of Music, on Monday evening, under the escort of the Local Committee of Members of the Society and officers of the Baltimore and Ohio Railroad. This Committee will have charge of all arrangements at Baltimore.

Headquarters at Baltimore will be at the Carrollton Hotel, where arrangements at special rates have been made for the accommodation of those attending the Convention.

On Tuesday morning, June 23d, a special train will leave Camden Station, Baltimore and Ohio R. R., Baltimore, at 9.10 A. M. The round trip tickets referred to below will be requisite on this train. They will also be good for any other trains during the Convention week.

Those who may be unable to arrive earlier can take train leaving New York at midnight of Monday, June 22d, and arrive at Baltimore at 6.45 A. M. Tuesday, in ample time for breakfast and for taking the special train at 9.10 A. M.

Members from the South and West can also arrive by the early morning trains.

This train will first stop at the general shops of the road at Mt. Clare, Baltimore, and an inspection of the shops will be made. The train will then proceed over the B. and O. R. R. to Deer Park, stopping at Harper's Ferry and a number of other points of special interest.

Deer Park will be reached in the early evening.

The Sessions will be held during Wednesday, Thursday, Friday and Saturday, except that on one of those days, to be specially announced hereafter, an excursion will be made by invitation of the B. and O. R. R. to the Cheat River Grade, Kingwood Tunnel, Tray Run Viaduct and other interesting points on the Mountain Division of the road.

The rate at the Deer Park Hotel for those attending the Convention will be $3 per day. The Hotel is very large, commodious and well kept.

Convenient arrangements will be made for Western members who desire to visit Washington and Baltimore after the Convention.

Trains leave Deer Park for the West at 4.29 A. M., 3.45 P. M., 9.21 P. M.

For the east at 12.40 A. M., 7.31 A. M., 12.40 P. M., 11.24 P. M.

Trains for either the West or the East may be thus taken on Saturday afternoon or evening after adjournment of the Convention; or a stay may be made at Deer Park over Sunday.

The Baltimore and Ohio Railroad Company over its entire system, also including the Ohio and Mississippi Railroad from St. Louis and Louisville, will sell round-trip tickets for one fare going and returning. This will extend to Baltimore and Washington on the East, and Cincinnati, Chicago, St. Louis, Louisville, Pittsburgh, Columbus and Toledo on the West.

Special arrangements for transportation will be made for other points, and announced to members notifying their desire to attend.

Limits of tickets and further arrangements as to transportation will be announced on special inquiry.

The special tickets from places named above will be on sale on and after June 20th, and to secure them, a certificate of authority must be presented signed by the Secretary of the Sociey.

Special programmes, with the titles of papers to be read and subjects to be discussed, will be prepared and issued.

The President of the Society, Frederic Graff, Esq., will deliver the Annual Address at one of the sessions to be held at Deer Park.

Members of the Society are invited to transmit to the Secretary papers that they are willing to present at this Convention, in order that a place may be given for them in the programme.

The families of members are invited to accompany them to the Convention.

The probability seems to be that this Convention will have a very large attendance from all parts of the country.

Frederic Graff, President, John Bogart, Secretary: *Committee of Board of Direction*:

*Committee of Officers of the Baltimore and Ohio R. R. Co*: C. K. Lord, Gen. Pass. Agent; James L. Randolph, Cons. Engineer, W. N. Bolling, Engineer of Real Estate; William P. Harris, Supt. Western Div.

*Committee of Members of the Society resident at Baltimore*: Charles H. Latrobe, Mendes Cohen, Francis H. Hambleton, Edward S. Safford, Frederick H. Smith, Jared A. Smith.

## Engineers' Club of Philadelphia.

*Record of Business Meeting, May 2d, 1885.*

President J. J. de Kinder in the chair; 45 members and 5 visitors present.

The Secretary reported that the house No. 1122 Girard Street had been secured for the Club, and that the Board of Directors were taking such action as would enable us to occupy it at an early day.

Messrs. J. E. Codman and T. M. Rogers, Tellers, reported the following gentlemen elected Active Members of the Club: Messrs. Harry B. Hirsh, Geo. B. Price, Louis Schutte, Max Livingston, John L. Gill, W. F. Dodge, S. P. Mitchell, Wm. H. Burr, Heber S. Thompson, Wm. J. Hoyt, and Frank H. Taylor.

Prof. L. M. Haupt, Chairman of Committee appointed at last meeting to prepare a Memorial to the Legislature of Pennsylvania upon

the Continuation of the Second Geological Survey of the State, presented the following report from that Committee:

To the Honorable Lieutenant Governor Chauncey F. Black, President, and the Honorable Amos H. Mylin, President pro tem of the Senate, and the Honorable James L. Graham, Speaker of the House of Representatives of Pennsylvania:

WHEREAS, The Engineers Club of Philadelphia reconize the gross errors and discrepancies which exist in all of the best maps which have been constructed of Pennsylvania and of individual counties in the State, which have been published since 1816, and which are based upon Melish's State Map, constructed under authority of the Legislature of that year: and

WHEREAS, There is a great demand among those citizens of the State interested in all surface improvements and in the developement of the natural resources of the State, for an accurate map, which shall establish the true geographical position of every point on its surface north and south, and east and west from every other point, and the elevation of all points above tide, so that the citizens of the Commonwealth shall have correct maps of their respective townships and counties on which surface improvements may be outlined, and upon which surveyors can place land lines, and mining engineers and geologists can trace mineral outcrops and areas; and

WHEREAS, The Board of Commissioners of the Geological Survey have entered into negotiations with the United States Geological Survey, and the United States Coast and Geodetic Survey, and a plan of co-operation has been proposed by which the United States Surveys will expend in the State for a Geograpical and topograpical survey $35,000 a year, if the State will expend $10,000 a year, and which co-operation now depends upon the granting of a State appropriation by the Legislature in accordance with the recommendations of the Board of Commissioners; and

WHEREAS, Such State maps are now being constructed by New York, Massachusetts and New Jersey, it is, therefore,

*Resolved*, By the Engineers' Club of Philadelphia, that they respectfully petition your Honorable bodies to speedily pass House Bill 497, entitled "An Act to provide for the continuance of the Geological Survey of the State," as originally introduced and committed to the Appropriation Committee of the House of Representatives, wherein an appropriation of $90,000 is asked, $20,000 of which provides for the continuance of topographical work and the commencement of the construction of an accurate map of the State, and your petitioners will ever pray.

Upon motion of the Secretary, the Report and Resolutions were unanimously adopted and the Chairman of the Committee empowered to forward the same, in proper form, to the Senate and House and to the individual members thereof

The Secretary announced that he had referred the recently offered amendments to the By-Laws to the Committee, which now has the complete revision of the By-Laws in charge, and is actively pushing its work to completion,

Mr. T. Everett Austin presented a paper on Fast Passenger Locomotives—giving a description of Locomotive No. 169 of the Central R. R. of New Jersey, also of the Class K, Pennsylvania R. R., and of Type D 33, Wootton Passenger Locomotive—designed for fast passenger service between New York and Philadelphia. He also exhibited photographs of the locomotives "G. F. Ward," for the New York, Philadelphia and Buffalo R. R., and of the "Pegasus," for the Boston and Lowell R. R., built at the Rhode Island Locomotive Works, Providence R. I.; also the principle dimensions of the latest design of passenger locomotives built at the Mason Locomotive Works, Taunton, Mass., closing the paper with a description, illustrated by a blue print, of a new design for a fast passenger locomotive.

Mr. Kenneth Allen presented extracts from a paper by Henry J. Barnes, M. D., on Purification of Sewage by application to land, with reference to the City of Boston.

Mr. W. F. Newell, member of The Civil Engineers' Society of Minnesota introduced by Prof. Haupt, presented a description of the Borup Coal Chute, which is designed to prevent accidents to pedestrians in street openings, for convenience in receiving or removing material, and for ventilation of cellars and vaults. It consists of a cylindrical sheet-iron tube, open in front, to permit the dumping or throwing in of the coal. It is raised to about eighteen inches above the sidewalk, by means of two lugs cast on the under side of the lid, which fit and lock in openings cut in top of chute, to prevent the removal of the lid without raising the chute above the elevation of the sidewalk. After a slight turn, the lid is taken off, and the throwing in of the coal commenced. When finished, the lid is put in place on top of chute, the reverse turn given, which locks lid to chute, and allows the latter to be lowered to grade of pavement. The lid cannot be removed without raising the chute; and when the chute is lowered, the lid is secured and cannot tilt, as can ordinary covers, when carelessly replaced. HOWARD MURPHY,

*Secretary and Treasurer.*

### Engineers' Club of Minnesota.

The Engineers' Club of Minnesota held a regular session on May 8th, Messrs. R. H. Sanford, W. J. McNulty and C. F. Tirney were elected to membership. Mr. Waters, engineer of the water board, presented a paper on the relative value of reserve machinery and reservoirs. The object of the paper was stated to be to point out some of the advantages that machinery has over reservoirs, where water is elevated by artificial means and has an inexhaustible source to draw from. The advantages of machinery over reservoirs in the water supply of cities are thus outlined:

First—As a reserve in case of accident.

Second—The ability to increase the pressure when required.

Third—The economy of reserve machinery in first cost over the reservoir.

Fourth—The quality of the water delivered by each system.

Under the first head it was shown that it is a necessity of all water-works that the water pressure in the mains have an uninterrupted flow day and night, and in order that they may be repaired it is necessary to have a reserve, and also in case of accident. The power to supply water in case of accident is the one great advantage claimed for the reservoir system—which is admitted, providing it is not being repaired itself, or empty, as is often the case, from some other cause. This is illustrated by the experience of one of the best equipped water-works in the country. There were two ten million gallon pumps, one of which broke down. There was a reservoir of 20,000,000 gallons capacity, which could not be made to supply the city at the outside for more than five days, and it required much longer than that to make the repairs. Additional machinery had to be purchased, which might as well have been purchased in the first place, and the reservoir dispensed with.

In the second place it was shown that the reservoir being at one fixed elevation, the pressure cannot be increased except by closing the gates in the supply main. With the rapid spread of growing cities it is often of advantage to be able to increase the pressure to meet the domestic demand. The erection of higher buildings also may necessitate increased pressure. The advantage of having the pressure for fires, without being at the expense of maintaining fire pressure, is very great. The time it has taken to keep up fire pressure in Minneapolis has only averaged one hour in fifty-one the year past. When a system of water-works can give fire pressure on the mains, every hydrant is a steamer. When the pressure is lacking, the amount of water that can be thrown on a fire is limited to the capacity and number of fire engines.

Minneapolis and St. Paul are fair illustrations of the two systems. Minneapolis, by having adequate pumping machinery, can raise the pressure on the mains from about fifty pounds domestic, to over one hundred pounds, fire pressure. In St. Paul the domestic pressure is about the same, with no means of increasing it in case of fire, and consequently all the water that can be thrown is limited to their six engines. While Minneapolis, that has the same number, can supply her steamers with water, helping to increase their pressure, and in addition the pumps could take care of six other fires requiring an equal amount of water. Although the two systems are of about the same capacity, Minneapolis can furnish about seven times as much water for fire purposes. Moreover, there is no time lost in getting up steam.

The assertion that the repeated increase of pressure in the pipes will ultimately destroy them is something that can only be determined after the lapse of years. The increase of pressure in this city on account of fires would not average more that 365 times in one year, and allowing the maximum variation of pressure the pipes would not be destroyed from that cause in over a million years. As showing the economy of reserve machinery, the case previously referred to was cited. The reservoir cost $250,000, while the reserve machinery that had to be purchased to supplement the reservoir cost $65,000. So that if the pump had been purchased in the first place, instead of building a reservoir, the city would have saved $185,000.

In the fourth place, it was shown that machinery delivers the water to consumers before it has time to deteriorate. In all the reports of other cities there is not one complaint against machinery on this point; but against the reservoir there are very many. Then followed a number of quotations from reports, treating of the impurity of water drawn from reservoirs.

The members of the club indulged in a short and rather scattering discussion of the paper. Messrs. De la Barre, White and Newman were appointed a committee to arrange for an excursion to Minnetonka some time during the summer. The club then adjourned.—St. Paul *Pioneer Press.*

### Liverpool Engineering Society.

The usual fortnightly meeting of this society was held at the Royal Institution, Colquitt-street, on April 22, the president (Mr. W. E. Mills) in the chair. A paper by Mr. W. Goldstraw, entitled "The Relation between Engineering and Architecture," was read by the author. The relations between engineering and architecture are, on a reduced scale, the relations between science and art. Engineering may be said to be that entire system of knowledge and skill which ecomprises all mechanical pursuits so far as they supply the material wants of men. Architecture, or the art of ornamental and ornamanted construction, as applied to buildings, is the development and refinement of an important branch of engineering. They were both formerly practiced by the same persons, but have become separate pursuits on the modern principle of the division of labor; and the requirements of science have made it difficult to follow both profossions at once with success. It is desirable that the engineer should be more of an architect, and the architect more of an engineer. At the same time the two pursuits should be kept even more distinctively separate than at present. But whilst the engineer or the architect practices his special calling only, he should have a considerable knowledge of the other profession. Indeed, as both avocations are concerned with building, it would, probably be a successful arrangement sometimes for an engineer and an architect to join in partnership. By this means, if the work done were of good quality, they might get many commissions which either of them by himself would fail to secure, or would imperfectly carry out. In such cases the competing professions and the public would be mutually benefited.

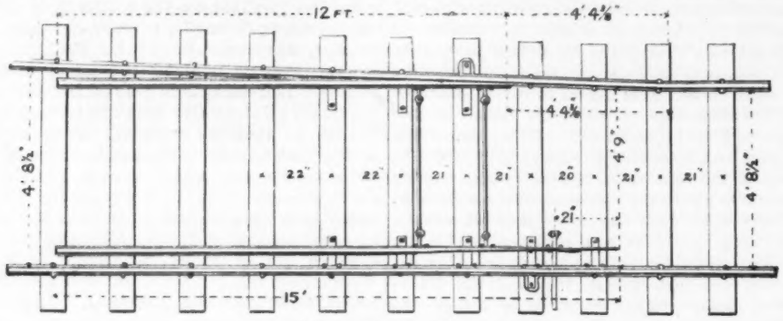


FIG. 86. BRAHN'S SWITCH.

## TRACK.*

BY W. B. PARSONS, JR., C. E.
ROADMASTER SUSQUEHANNA DIVISION ERIE R. R.

(*Continued from page* 316).

Of the second method of working the safety spring, that is to have the first pair of wheels throw the points fully, and not spring them each time, there are many patterns, of which we select the following: Brahn, of the Jersey City Iron Works, makes an automatic switch stand, for in this class of switches the safety device lies in the stand, a vertical section of which is given in Fig. 85. The shaft $G$** is continuous,

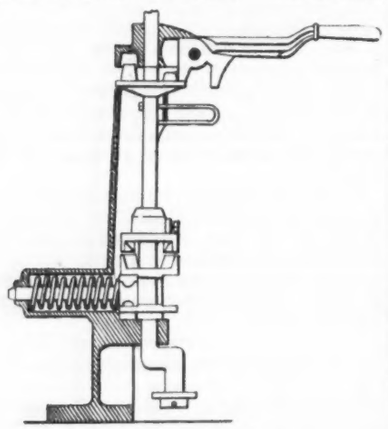

FIG. 85—BRAHN STAND.

having attached to it at $g$ the connecting rod by an eye according to the usual manner. The handle $I$ is rigidly connected to the shaft through the hinge $H$. We thus have simply an ordinary switch stand operating precisely like those shown in Figs. 64 and 65. In a horizontal chamber, however, lies a spiral spring pressing against a plunger $E$, and against the plunger a cam $D$. This cam has attached to it jaws $C$ fitting the jaws $B$ which are fastened to the shaft. Such are the parts. When the switch is fully thrown the projecting arm on the handle has passed by the boss $a^3$ so that it can be depressed, and the staple $J$ passes through a slot in the handle, forming a place for attaching the lock.

As the handle is depressed the standard $G$, being loose in its bearings, falls and the two sets of jaws engage, when the whole arrangement is held by the rigidity of the spring. When, however, a force is applied to the connecting rod as, for instance, wheels pressing against the points misplaced, it is transmitted to $g$ and the stand still locked is automatically thrown by the compressing of the spring. It will be noticed that all previous work is done with perfectly rigid connections and the spring remains idle without strain until actually called into play. The switch stand can be obtained in two styles, either to operate like the Lorenz, or else to have the points permanently thrown by the first pair of wheels. When it is worked on the principle of the Lorenz, it is superior to it, for this stand cannot be locked until the points are properly in place. Brahn,

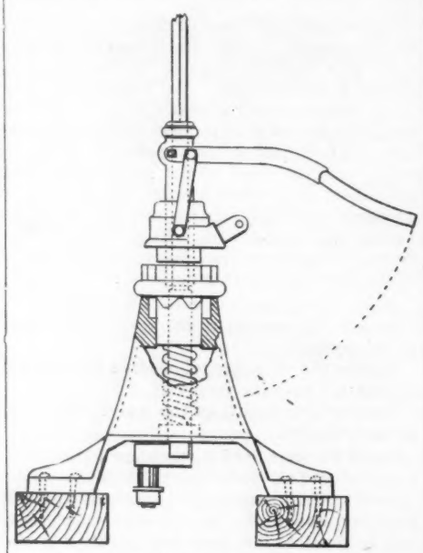

FIG. 87—SNOW STAND.

however, has further improved it, by adding a simple device so that the same stand by easy adjustment can be made to let the points fly back; or be thrown and remain so; or fly back for one track and stay thrown for the other, that it be always right for one of them. This stand has been described in detail as being the most ingenious and certainly the equal of any in the market. The whole stand is encased in a cast-iron jacket, only part of which is shown in the section. Brahn also makes a difference in the points themselves by manufacturing the turnout point, or the one which is open or inoperative when the switch is set for the main track, longer than its mate by about 3 feet, the object being to have it act as a guard rail. Thus the wheels of a train running against the switch as soon as they get behind the long point are prevented against any possibility from mounting the other point as they run over it, even should any of them be "sleeved" so as to crowd that way. As a rule it is not advisable to have a switch point act as a guard rail, and in this case it does not, being set wide, only in the event of a crooked truck or loose wheel which might tend to catch on any small obstruction, Fig. 86, shows the arrangement. The continuous rail of the side track should be curved just as if both points were of the full length, and the gauge of the track just in front of the points should be widened ½ inch. This, however, it is well to do with all split switches and the connection bars should be of such lengths as to demand it.

Another excellent form of automatic stand which causes the points to be fully thrown is the Snow stand of which Fig. 87 is an elevation and vertical section. This stand, as they all should, gives rigid connection between the lever and the points when being operated by hand. When working automatically the spring is compressed and the jaws fly past each other. The handle folds down to lock. This stand takes two head blocks to support it.

(TO BE CONTINUED.)

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** The lettering was omitted in making the cut.—ED. ENG. NEWS.

## CORRESPONDENCE.

### Intermittent Spring.

OFFICE OF AMSTERDAM WATER WORKS,
AMSTERDAM, N. Y., May 11, 1885.

EDITOR ENGINEERING NEWS:—A peculiar case in hydraulics has been brought to my attention by Capt. George M. Vahees, of this place, which I would like to have explained by some hydraulic engineer. A spring of water is brought a distance of 1,075 feet, with 7 feet head through a ¾ "inch pipe; the stream is reduced at the outlet to ¼." The spring is boxed and does not freeze in winter, and the head remains the same during the entire year; there are no traps in the pipe line. The pipe was full during the whole winter and until the extreme hot weather of summer, when it slacks off and stops. A force-pump is then put on, and the stream runs free again for a week and then requires the use of the force-pump again. No sediment or organic matter can get in the pipe and none is brought out with the force pump. A blow off was put in last summer at about the center of the line—but without any effect whatever. What is the solution of the problem? Respectfully yours,

A. H. DEGRAFF.

[We should say that you have a case of the well-known intermittent spring problem; during the winter the subterranean reservoir supplying the spring is well filled and the water flows freely; as the supply fails in summer, the level of this reservoir falls to or near that of the entrance of your pipe line and the flow ceases. The action of the force-pump again draws in water from the underground feeders and raises the level of source of supply and the water flows until this is once more exhausted. ED. ENG. NEWS.]

### Problem in Mechanics.

PHILADELPHIA, May 9th 1885.

EDITOR ENGINEERING NEWS:—I am much surprised to find in your issue of this date a "Problem in Mechanics" (in which the author makes some strictures upon the "Pocket Book") printed over my signature; doubtless through an error in the composing room. Will you kindly make amends by allowing me to give what I believe are the correct replies to your correspondent's enquiries?

His error consists, I think, in concluding that the 2 pound weight A in his Fig. 3 produces a tension of 2 pounds in the string: 1 pound of which balances the smaller weight B, while the other pound gives motion to it. In other words, he assigns the whole 1 pound of surplus or net or moving force to the task of moving the counterpoised 1 pound weight B upward, forgetting that two thirds of this surplus pound of force must needs be employed in moving A downward, leaving only one third to give motion to the small mass B. The tension in the string will therefore be, not 2 pounds as wrongly supposed, but only 1 1-3 pounds.

In Fig. 2, if the force applied at A merely produces *the same tension* in the string that the two pound weight A in Fig. 2 does, namely, a tension of 1 1-3 pounds, the the weight B will have the same upward velocity as in Fig. 3, namely, one-third that of a falling body. But if the force A Fig. 2 is *so much greater* than 2 pounds as to maintain a tension of 2 pounds in the string, then one of those 2 pounds will counterpoise B, and the remaining 1 pound will give it an upward velocity equal to the downward velocity of a falling body.

As to the "work" done in the several cases, I think the answer will differ, as suggested by your correspondent, according to the definition adopted for the term "work," and according to the portion of the system under consideration at the time. The authorities give what seem to me very vague and unsatisfactory definitions of the term. We are generally told that "work" is equal to the *resistance* overcome, multiplied by the distance through which it is overcome; or to the *force overcoming it*, multiplied by the same distance. But these two products are plainly not equal; for a *force* of 1 pound will not *move* a body against a resistance of 1 pound, but will merely *balance* the resistance and keep the body at rest. The product of the *force* into the distance must therefore be *greater* than that of the *resistance* into the distance; else there can be no motion. This is most plainly illustrated by the case (Fig. 1) of the body falling freely; for here the force is 1 pound, and the resistance is nothing; and, as intimated by your correspondent the "work" done (in a motion of 1 foot) is 1 foot-pound, or nothing, according to the definition adopted.

JOHN C. TRAUTWINE, JR.

[We must humbly ask Mr. Trautwine's pardon, for

our blunder in attaching his name to the correspondence of another party; especially as that correspondence was neither very complimentary to the work which he now represents, nor to his own methods of reasoning. It is easier to see how the thing happened than to correct the wrong impression sent out, and we can only apologize and publish his answer to what is *not* his letter. We have received several other replies to the same miscredited correspondence, but owe Mr. T. the first chance to criticise, and believe he has virtually covered the ground.—ED. ENG. NEWS.]

## LITERATURE.

*Applied Mechanics*, by GAETANO LANZA, S. B., C. & M. E., Professor of Theoretical and Applied Mechanics in the Massachusetts Institute of Technology. New York: John Wiley & Sons, 1885.

This is an octave volume of 729 pages. Like some other recent books the size of the printed page is 4 × 6¼ inches, while the size of the leaf is 5¾ × 9¼ inches. As a consequence the upper and lower margins are unnecessarily wide and the outer margin appears narrow. By reducing the top and bottom margin about forty per cent the book would be reduced a more convenient one to handle. Rankin's Applied Mechanics has the same height of printed page 6¼ inches, but the bound volume is two inches shorter than that of Professor Lanza.

The first and second chapters of the book are devoted to theoretical mechanics. There the fundamental definitions and conception of force, mass and momentum are set forth in a clear and satisfactory manner. In fact we can recall no work which so concisely and clearly states the principle that the momentum of a moving body measures the constant force which could produce that motion in a unit of time. These two chapters embrace 137 pages.

The third and fourth chapters, which relate to the determination of strains in roof and bridge trusses, cover 73 pages only. For roof trusses the graphical method is employed and for bridge trusses the analytical. In discussing the latter the train load is alone considered and no reference to locomotive excess is made. Bowstring trusses and other forms with non-parallel chords are not mentioned. The fifth chapter treats of center of gravity, a subject which might have been more properly discussed in the theoretical part.

The sixth and seventh chapters, embracing 323 pages are devoted to the elasticity and strength of materials. The formulas of Fandardt and Weyrauch are introduced at the very start—a procedure which seems to us of doubtful utility for the student. The definition given for the term "strain" appears also unnecessarily complex. The usual formulas for the strength of beams and columns are here deduced, and numerous tables of the results of tests are given. Among these are tables showing the interesting experiments made by Professor Lanza on full-size beams of timber, from which the important conclusion is deduced that the strength of marketable lumber is that of green lumber only.

The eighth and ninth chapters devote 104 pages to the discussion of continuous girders, arches and domes, while the last chapter, containing 64 pages, treats of the mathematical theory of elasticity and internal stress.

The book is stated to be the result of the experience of the author in teaching the subject of applied mechanics during the last twelve years. Hence it will naturally be of interest and value to professors of engineering everywhere. It now seems to be the fashion for professors to write voluminous books, large portions of which are filled with tables, formulas and opinions taken from other works or from periodicals. Professor Lanza's book is an improvement on some of its predecessors, but we fear that his seventh chapter will scarcely tend to give definite ideas to students. On wrought-iron bridge columns, for instance, are presented eight pages of tables of tests, and five pages showing the formulas proposed by Bouscaren, Cooper, Emery, Merriman, Lovett and Burr. On rivetted joints twenty-four pages of tables are represented, together with the rules and opinions of Wilson, Box, Unwin, Fairbairn and Forney. To engineers and designers such compilations of facts and opinions are certainly valuable, and as students are embryo-engineers it may perhaps be of some advantage to let them have a broad view of the field, even at the expense of definitions.

WAR BALLOON: Philadelphia papers say that Mr. Russell Thayer, of that city, has been authorized by the U. S. Ordnance Board to construct a monster war balloon of his invention, to cost about $10,000. It will have a diameter of 60 feet, and length of 185 feet, is cigar-shaped, and to have a lifting power of 7 tons. The motive power is to be compressed air and while the description of its proposed working is rather obscure, great things are promised upon its completion.

ENGINEERING NEWS Three months for One Dollar.

## Culvert Pipe for Railroads.

In regions devoid of stone the material to be used in small culverts is a subject for consideration. Among these materials the one found to possess all the elements of strength, durability and economy, when applied to the purpose named, is "double strength," vitrified clay sewer pipe.

In 1879, Blackmer & Post, manufacturers of sewer-pipe in St. Louis, Mo., first made a special pipe for railroad purposes, under a requisition from Col. H. C. Moore, Chf. Eng. of the Eastern Div., Indianapolis, Decatur & Springfield R. R.; the shell, according to the specification, being equal in thickness to one-twelfth of the diameter of the pipe. This pipe has been used by many railroads; over one hundred companies being enrolled on the books of the firm with orders ranging from 500 to 10,000 lin. feet. There have been no recorded instances of failure from effect of frost, or pressure of earth and trains.

The pipe is easily inserted under an embankment where required; it being only necessary to tunnel through the roadbed to the dimensions demanded by the pipe, and then solidly bed the pipe by ramming the earth well about it.

The following instructions for laying culvert pipe are taken from the catalogue of Messrs. Blackmer & Post:

HOW TO LAY CULVERT PIPE.—"If you have never used any kind of pipe for culverts, we may be able to give

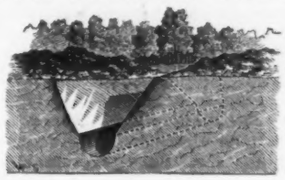


FIG. 1.

you some ideas that will be of service to you in laying our culvert pipe, and enable you to secure the best and most permanent service from it. The too common way of doing it has been to dig a trench, put the pipe in carelessly and cover it up. This is wrong. The

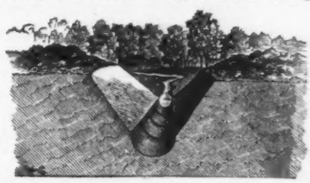


FIG. 2.

bottom of the trench should be rounded out to fit, as nearly as possible, the body of the pipe from the lower surface up to the horizontal centre line; then cut little depressions in the bottom of the trench to fit the sockets, so that when the pipe is laid, its entire lower surface, from end to end, will rest solidly on the ground (see Figs. 1, 2 and 3). When the ground is soft

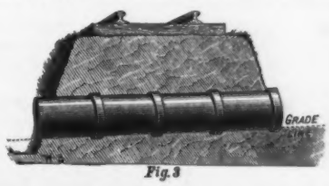



*Fig. 3*

or sandy this cannot be done, but the same result may be obtained by carefully ramming the loose earth under and around the lower surface of the pipe, after they are placed in position.

"When this is done properly, it is a matter of no consequence how high the bank is above the pipe, for it

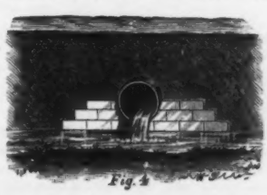


*Fig. 4*

cannot be broken by the weight of the earth. If the face of the bank is solid, and not likely to cave or slide, the end pipes need no protection other than to secure a firm rest for their lower surface. Sometimes the earth will be found hard enough to obtain this without other protection; if not, then a foundation of brick, stone or cement should be made to receive the end of the pipe, and extended up to the center line of the pipe (see Fig. 4). If, however, from heavy rains or overflows, the bank is liable to be undermined, then this parapet wall should be extended up high enough to give the desired

FIG. 5.

protection. The joints should be put together with good cement, plenty of it, and not much sand in the mixture: care should also be taken that the inside of each joint is scraped out when cemented, in order that no loose cement be left projecting into the pipe, which, when it hardens, will help to check the discharge.

"In northern latitudes, where severe cold prevails, the culvert should have a good fall, and be so constructed that it will drain itself (see Fig. 4); for if the pipe is allowed to stand partly full of water, as would

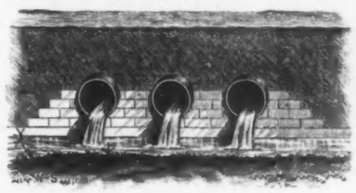


FIG. 6.

be the case where the outlet of the culvert was so low as to admit of backwater (see Fig. 5), the expansion of the water in freezing will burst the pipe as certainly as it would burst an iron pipe or a solid rock.

"The diameter of these pipes are 12, 14, 15, 16, 18, 20, 21, 22 and 24 inches; length, 2 feet in the clear.

"When the capacity of one pipe is not sufficient, two or more may be laid side by side, as shown in Fig. 6. This practice is quite common, and there is an advantage in it, in that the water would not need to rise so high to utilize the full capacity of the pipes, but they should be placed far enough apart to secure a solid bed for each pipe. In our illustrations we have shown only the outlet of the culvert, but it will be understood that both ends need the same protection.

"Of course no arbitrary rules can be formulated for such work as this, but we have aimed to give, in a general way, the main points to be considered, necessarily leaving much to the better discretion and judgement of the engineer in charge of the work."

Culverts made of this pipe are more durable than those made of either iron, brick or timber. They are equal to stone, and much cheaper than any other kind.

Among the many railroad companies who have this pipe in use, we mention the following who have been the largest purchasers, and to these parties reference is made:

Richmond & Danville Extension Co.; Texas & Colorado Improvement Co.; Vicksburg, Shreveport & Pacific Railway; Alabama Great Southern Railway; Burlington Cedar Rapids & Northern Railway; Chicago & Northwestern Railway; Chesapeake, Ohio & Southwestern Railway; Chesapeake & Ohio Railway; Detroit, Lansing & Northern Railway; International Railway Improvement Co.; Inter-State Improvement Co.; Kansas City, St. Joseph & Council Bluffs Railway; Pacific Railway Improvement Co.; Plant Investment Co.; Chicago, Burlington & Quincy Railway; St. Louis & San Francisco Railway. (ADV.)

## Brick Cylinder Foundations.

Solid and hollow cylinders of brickwork make in some situations good foundations without a cast-iron sheel or incasement, though the ironwork doubtless increases the crushing resistance. In India, at the Sutlej Bridge, and elsewhere on sandy soils, brick cylinders from 12 feet to nearly 20 feet in diameter have been used for bridge piers on the same principle as shafts are sunk in this country through clay, gravel, bowlders and sand. The brickwork is usaully 3 feet or more in thickness, the first 10 feet or less in height being built upon a driving shoe or kerb of iron or hard timber or both combined, placed on the ground and gradually sunk straight and vertical by undermining it from within, and loading it on the top with another length. It is thus sunk 70 feet or more, at the rate, perhaps, of 2 feet a day. The Plantations Quay, at Glasgow, Scotland, is founded on brick cylinders, grooved and tongued to each other, sunk in quicksand on to rock to an average

depth of 52 feet. Each cylinder is made up of a pile of brick rings in Portland cement, 2½ feet deep, 2½ feet wide in the rim and 7½ feet in internal diameter.

### The Permissible Strain upon Brick work.

In the excerpt minutes of the proceeding of the British Institution of Civil Engineers we fined the results of some experiments made to ascertain the crushing strength of brick-work composed of different kinds of brick with various mortars. The mortars used were made with either lime or Portland cement, in each case mixed with sand, and, as the experiments were made by Dr. Bohme, of Berlin, Germany, the bricks were those chiefly in use in the city. The composition of the mortar was found to have great influence upon the strength. Brick-work set in a mortar composed of one part lime and two parts sand possessed only 44 per cent. of the strength of the bricks alone, while a mortar composed of one part Portland cement and three parts sand raised the percentage to 63. A great number of tests were made, full particulars of each being given. The results obtained are summarized in the following table, in which the safety limit is taken as one-tenth of the absolute crushing strength:

| Description of Brick. | Average crushing strength of brick alone. | Permissible strain upon brickwork with mortar composed of | | | |
|---|---|---|---|---|---|
| | | 1 lime, 2 sand, 4.4 per cent. | 1 lime, 1 cement, 16 sand, 4.8 per cent. | 1 cement, 6 sand, 5.5 per cent. | 1 cement, 3 sand, 6.3 per cent. |
| | Lbs. per sq. in | Lbs. per square inch. | | | |
| Ordinary stocks..... | 2,930 | 129 | 139 | 161 | 185 |
| Selected stocks..... | 3,669 | 162 | 176 | 202 | 232 |
| Clinkers..... | 5,390 | 237 | 259 | 296 | 341 |
| Porous bricks..... | 2,617 | 115 | 125 | 144 | 165 |
| Porous perforated bricks ..... | 1,195 | 53 | 57 | 65 | 75 |
| Perforated do..... | 2,759 | 121 | 132 | 152 | 171 |

The figures are in each case higher than those upon which the building regulations of Berlin are based.

## THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.; M. INST. C. E.

(CONTINUED FROM PAGE 285).

DCCXLVI, MITCHELL, ONTARIO.

Mitchell, Perth Co., Ontario, is in lat. 81° 15′ N., long 43° 20′ W.

Water-works were built by the town in 1873-4 taking the supply from surface water.

From the river the water is pumped by two steam pumps of 16-inch cylinders, made by Inglis & Hunter, directly into the mains.

Distribution is by 1¼ miles of cast iron pipe of 6 and 4 in. diameter with 10 fire-hydrants.

The works are for fire protection only and have cost $15,000 which is the amount of the bonded debt at 6 per cent. The yearly expenses of maintenance are $900. The population is 1,802.

Robert Chrystie is town clerk.

DCCXLVII, MOBILE, ALA.

Mobile, Alabama, in lat. 30° 45′, N., long 88° W., is on a level sandy plain at an elevation of about 15 feet above tide in Mobile Bay. It is a port of entry, and one of the leading cotton markets in the United States.

Water-works were built in 1840 by a private individual who contracted with the city to furnish it with water from Three Mile Creek, a distance of about 6 miles. This contract was to run for twenty years, at the expiration of which the works were to revert to the city on payment of an actual valuation. The expiration of the contract during the war prevented a just settlement, and the works are now owned by Louis Stein, son of the builder. The water is now taken from the creek and springs and is pumped by the double-acting horizontal pumps of 10 inch diameter and 4 feet stroke, made by the West Point Foundry Co., driven by two breast wheels 16 feet in diameter, and also by a Blake compound condensing pump of 14 and 24 inch steam and 14-inch water cylinders and 24-inch stroke to a stand-pipe.

Distribution is by 22 miles of cast-iron pipe of 10 to 3 inch diameter with 150 fire-hydrants, 1,200 taps and one meter. Service pipes are of lead. The city does not pay for fire service. The works have cost $200,000. There is no bonded debt. The yearly expenses of maintenance are $8,000. The receipts are not stated.

Louis Stein superintends the works.

The population in 1870 was 29,132.

DCCXLVIII, MORG N PARK, ILL.

Morgan Park, Cook Co., Illinois in lat. 41° 50′ N., long, 87° 45′ W.

Water-works were built in 1874 by a private company after plans of D. Halladay, taking the supply from an open well 40 feet deep. The water is pumped from the well by a double acting force pump of 5-inch water plunger and 15-inch stroke, driven by a windmill 25 feet in diameter, made by the U. S. Wind-Engine and Pump Co., to a wooden tank 14 feet high and 24 feet in diameter, holding 50,700 gallons, placed on a timber trestle 24 feet high, located on high ground.

Distribution is by 3 miles of wood pipe of 4-inch diameter. The population in 1880 was 187.

No further information can be obtained.

## WATER.

THE bursting of a water main caused the loss of $40,000 by fire in Rahway, N. J. last week.

CLEVELAND, O. councils have ordered the laying of a large amount of water-pipe during the coming season.

A. M. GILBERT, M. M. Moore and Caswell A. Sharpe are the incorporators of the Mattoon Water-works, with $100,000 capital.

PIERRE, Dakota, expects the present season to see completed its city water-works system, costing from $50,000 to $60,000.

DULUTH, Minn., water-works furnished in April 15,402,304 gallons of water an average of 513,410 gallons per day, or 32 gallons per head. In March the daily consumption was 515,000 gallons.

A BILL to dam the Delaware River at Trenton, N. J. long lying dormant in the hands of the Corporation Committee of the N. J. Senate, is being stirred up again.

AT Ash Fork, a station on the Atlantic and Pacific Railway, in Northern Arizonia, the water supply is brought by rail a distance of sixty miles and sold for fifty cents per barrel.

THE Kings County, N. Y., Water Supply Company, has obtained the assent of its stockholders to mortgage its property for $300,000 in order to pay off some old debts.

PHILADELPHIA COUNCILS, on May 7, appropriated $300,000, from the surplus of Gas Loan No. 9, to the Water Department for reservoirs and replacing old pipe

A FRANCHISE has been obtained for the construction of water-works at Sharon, Pa. Bullock & Mercer of New York are the Contractors and Geo. H. Pierson C. E. the Engineer. There will be 80 fire hydrants; no other particulars yet given.

THE water works of Greenville, Ill. were officially tested on May 7, and the works accepted by the City Councils. Carroll E. Gray, Jr., was the builder and the pumps from the Blake Co. have a capacity of 750,000 gallons.

PRAIRIE DU CHIEN, Wisconsin, has eight flowing wells that throw water sixty feet above the ground. Two wells over a thousand feet deep run a large flouring mill, another supplies the water-works and fire hydrants for the city.

PLANS and specifications are being prepared for a water-works in Middleboro, Mass., and it is expected that work will be commenced in about two months. The supply will probably be taken from Clarke's spring, one mile south of the village.

FAIRBANKS, Morse & Co., contractors for putting in the water-works at Eau Claire, Minn., are arranging to commence active operations about the 12th inst. The work will afford employment to upward of two hundred and fifty men.

EAST BOSTON, Mass., is discussing the question of either replacing the old pipe in its distribution system at a cost of $10,000, or trying to clean them of the rusty accumulations of 35 years use. The latter plan by pretty general consent is not considered economical or even feasible under existing circumstances.

A LONG, lofty, and wide subterranean aqueduct, in perfect condition, has just been discovered on the site of ancient Carthage, Twenty-two Phœnician tombs of the First Epoch, together with a number of Phœnician and Etruscan vases, all well preserved, were likewise brought to light. A Latin inscription placed over the site of some baths, was also found.

CHIEF ENGINEER LUDLOW of the Philadelphia Water Department, has commenced a vigorous campaign against the defilers of the water of the Schuylkill River. A large number of parties have been notified to stop the flow of objectional matter into the river, and they will be proceeded against criminally if these orders are unheeded.

THE April report of the engineer of the water-works of Peabody, Mass., gives the number of gallons of water pumped as 18,274 310, an average of 609,143 per day. The average number of pounds of coal consumed daily was 1505, a total of 45,171 pounds for the month. There were 404⅓ gallons of water pumped for each pound of coal consumed.

CHARLES KEIGHLEY, a prominent resident of Vineland, N. J., has obtained from the Council of the borough the privileges of establishing water-works to supply water to the residents of the place. He intends obtaining the water by means of driven wells, and is now experimenting in that direction. He has driven an inch and a quarter pipe to a depth of fifty-six feet, and obtained water from it at a rate of six gallons per minute.

ST. LOUIS, Mo., Councils lately passed an ordinance ordering the closing of all wells in that city. A "well-owners' association" has been organized to resist this "cruel and arbitrary action" of the city authorities, and report says the "owners" will probably come out victorious. Pollution of the subsoil and the contamination of the underground water sources are subjects evidently not studied with profit by the citizens of St. Louis.

THE construction of the Paducah, Ky., water-works is to commence June 1. The Paducah Water Supply Co., of Baltimore, Md., will build them, Chas. D. Gaither, President; E. F. Fuller, Chief Engineer and Messrs. Bullock & Mercer, contractors. The population is 15,000. Water is to be taken from a receiving and filtering basin, 2,000 feet long, located in the Ohio River, and conveyed across the Tennessee River into the city. There will be two pumps of 2,000,000 gallons each; a stand-pipe 175 feet high and 22 feet in diameter; 12 miles of pipe from 16 to 6 inch diameter, and 150 fire hydrants.

MEASURING DEEP SEA WAVES.—The Hydrographic Office of the Navy Department has secured, by means of observations made by United States naval vessels, data respecting the dimensions and speed of deep sea waves. The longest recorded wave measured a half mile from crest to crest with a period of 23 seconds. Waves having a length of 500 or 600 feet and periods of 10 to 11 seconds are the ordinary storm waves of the North Atlantic. As to the height of waves the most trustworthy measurements show from 44 to 48 feet to be a remarkable height. Waves having a greater height than 30 feet are not commonly encountered.

INSURANCE premiums in Philadelphia have made a general advance, and in some old companies the rate has advanced from 15 to 30 per cent. The reasons given are, the increase in fires over the country generally; the great height of buildings in the large cities; the prevalence of elevators with their shafts; the extensive use of steam power and the general introduction of the distillations of petroleum for lighting and heating purposes. In Philadelphia, insufficient water mains in the business portions of the city are notably the cause of an increase in rates; they are in many places much too small for the supply demanded.

THE Portland Water Supply Co., of Maine, is considering the water waste problem, viz.: a new supply from Lake Sebago for Munjoy Hill. The present total supply to Portland is 9,441,000 gallons daily, or 279 gallons daily for each inhabitant. According to a measurement of the flow from the sewers, on February 23, 8,079,000 gallons were discharged daily; allowing 84 gallons per head as an ample per capitum supply, 2,836,000 gallons should have been sufficient, whereas nearly three times that amount was consumed or wasted. Two of the Portland School buildings were found to consume 32,825 gallons per day, or more than 21 school buildings in Boston, where only 26,196 gallons were supplied. Waste prevention is an important question to be considered by the good people of Portland.

# NEWS OF THE WEEK.

## Miscellaneous.

**Stone for the Forth Bridge.**—As indicating to some extent the magnitude of this important engineering work, it may be mentioned that close upon 12,000 tons of stone from Carmylie quarries had been shipped from Arbroath Harbor.

**The Channel Tunnel Bill Defeated.**—London, May 12.—In the House of Commons this afternoon Sir Edward Watkin, Liberal, moved the second reading of the Channel Tunnel bill. Mr. Joseph Chamberlain, on behalf of the Board of Trade, opposed the measure, and he stated that the Government was opposed to the further progress of the bill. The opposition cheered this declaration. The bill was then rejected by a vote of 281 to 99.

**Ivy vs. Dampness.**—Woodbine and ivy on brick buildings absorb all moisture there is in the bricks and mortar, and the presence of the foliage acts as a shield, turning severe driving rains away from the walls. The vines derive most of their sustenance from the ground, and do not give out moisture from the rootlets that cling to the walls.

**Petroleum Fuel.**—It is the opinion of many eminent British engineers that the English coals will gradually cease to be sent to the Mediterranean, and even the Red Sea, as the use of petroleum refuse in engines becomes better understood. Already it is the only fuel in use on the Caspian, either in the mercantile marine, in the Russian gunboat flotilla or on the railways, and even in domestic stoves it is in favor throughout the Caucasus. At present, in the countries of the East much oil refuse is poured into the sea as the only way to dispose of it.

**Garbage Dumping in N. Y. Harbor.**—A bill is now before the New York Legislators looking toward an improvement in the method of disposing of the garbage of New York and Brooklyn, and the protection of the health and interests of the inhabitants of Kings, Richmond and New York Counties and Coney Island. Assemblyman Earl, who introduced the bill, says that New York alone collects annually 1,000,405 cubic yards of refuse, sufficient if stationary to block up every channel in the harbor. The trouble seems to lay in lack of appropriation to remove the material to a sufficiently remote dumping ground, and want of policing to see that the existing law is carried out. Garbage is often dumped far within the prescribed limits. Cremation, treatment with chemicals and other methods are being discussed for the lessening of what is already a grave and threatening evil.

## Contracting.

**The Cape Cod Canal** has been excavated about one-fourth of a mile inland from Barnstable bay, and the dredger is now at work.

**The Keith Car Manufacturing Company** of Sandwich, has an order for fifty cars to be built for the Boston & Providence Railroad Company.

**The Wason Car Company,** of Springfield, Massachusetts, has received a contract for $100,000 worth of cars for Panama.

**Car Contracts.**—The Boston & Maine is having 100 freight cars built at Laconia, which will be equipped with the United States automatic coupler.

The Boston & Lowell now gets beautiful mahogany finished passenger cars at Laconia for about $3,200, which two or three years ago would have cost over $5,000.

**The Versailles & Midway R. R. Contract.**—The contract to build the Versailles and Midway Railroad, of which W. H. Graddy is President and Thomas H. Hays Vice President and General Manager, has been let to Dolan & Sweeney, of Lexington. Work is to begin the 8th inst., and is to be completed in sixty days.

**The Cascade Tunnel Contract.**—The contract for the contemplated tunnel on the Cascade division of the Northern Pacific was awarded on the 12 inst. James Mair, who built the Bozeman and Mullan tunnels, and Herman Clarke, contractor for the Yellowstone and Rocky Mountain divisions of the road, are said to be among the bidders.

**Market Street Bridge, Philadelphia.**—Philadelphia Councils on May 8th, passed in the Common Branch an appropriation of $1,000 000 for a new bridge over the Schuylkill River at Market Street. This is the structure practically let last year, but work upon which was not commenced owing to lack of legal means of paying for the same. The new loan of $3,000,000 just authorized by the Pa. Legislature now furnishes the funds.

**Sixteen Locomotives** were shipped from the Paterson, N. J., shops during April—a considerable increase over the previous month. Of these, six were from the Cooke Works for the Minnesota & Northwestern Railway, and ten from the Roger Works, of which four were the balance of the Manhatten Elevated order, two for a Florida road, two for the Kansas City Railway, and one each for the Naugatuck and Chepang roads in Connecticut.

**Brooklyn Post Office Contract Awarded.**—WASHINGTON, May 12th.—The contract for stone work on the Brooklyn Post Office building was to-day awarded to the Bodwell Granite Company of Maine, at its bid of $94,000.

**The Pedestal to the Statue of "Liberty."**—Work upon the pedestal was recommenced, on Bedloe's Island, on May 11th. It is reported that sufficient money is on hand to warrent the committee in resuming operations upon the cut-stone portion of the pedestal; and Gen. Stone estimates that it can be finished in about 70 days. The preparation of the cut-stone has been going on all winter at Leet's Island, Conn. The estimated total cost of the pedestal is $300,000; about $70,000 is still required to complete it, it is said.

**Cleveland, O., Dredging Contracts.**—A small-sized war was inaugurated by the reading of a communication from the Board of Improvements, recommending that the dreding contract be given to W. E. Rooney of Toledo, whose bid was 17 cents per cubic yard for dredging, and $8 per hour for removing snags. Charges of conspiracy between contractors were made and a motion to recommit the matter to the Board of Improvements was lost. The resolution authorizing the board to enter into the contract was adopted. The next lowest bid was 22 cents per cubic yard.

**The New Navy.**—Advertisements will soon be issued from the Navy Department for plans and proposals for the construction of the new vessels which were authorized by the last Congress. The legislation for the construction of these vessels provided for two cruisers of not less than 3,000 nor more than 5,000 tons displacement, costing, exclusive of armament, $1,100,000 each; one heavily armed gunboat of about 1,600 tons displacement, costing, exclusive of armament, not more than $520,000, and one light gunboat of about 800 tons displacement, costing, exclusive of armament, not more than $275,000. Authority was given for the construction of these four vessels, at not exceeding the total cost for each as above specified in accordance with such final plan as may be determined upon after a revision and reconsideration of all designs which have heretofore been made. Secretary Whitney construes the law as authorizing the invitation of new designs in addition to those heretofore made and accordingly will issue the advertisement.

**The Dubuque & Northwestern R. R. Construction.**—DUBUQUE, May 6.—The directors of the proposed Dubuque & Northwestern railway to-day announced that they had perfected arrangements with the Minnesota Loan and Debenture company of St. Paul and the Minnesota & Northwestern Railroad company for the construction of said road. By the terms of this contract at least eight miles of the road must be completed this year, for which the company is to pay in cash $70,000 beside the cost of the right of way and depot grounds. Nothing more is to be asked of the people of Dubuque and vicinity until fifty miles are completed. The contract with the Minnesota & Northwestern, which now has a road about completed from St. Paul south to the northern line of the State of Iowa, is that the latter agrees to build its line to a junction with the former fifty miles from Dubuque, so as to make a continuous through line from Dubuque to St. Paul. When this line is completed the two are to be consolidated and operated as one road. The directors also say that they must secure $150,000 at once in cash or satisfactory securities as an earnest of good faith and ability to carry out the contract with both of these concerns.

**Toronto, Canada, Sewers.**—Tenders were opened May 5th for a number of works at Toronto, Canada:

Sewers.—Garrison Creek sewers were awarded to A. J. Brown at $32,848; Crawford Street sewer, Charles Farquhar, $2,598.80; Morse Street Sewer, A. J. Brown, $2,485.

Block pavement.—Tecumseh Street pavement, Burns & McCormack, pavement per square yard, 65 cents curbing 18 cts., crossing plates, per 100 pound, $2; Gifford Street, Ardagh & Leonard, 65 cents, 17 cents, $1.90; Markham Street, Ardagh & Leonard, 67 cents, 15 cents, $1.90; Richmond Place, R. West, 62 cents, 15 cents, $2.12½; Clarence Place, Richard West, 63 cents, 15 cents, $2.12½; Huron Street, Richard West, 63 cents, 15 cents, $2.12½; Crawford Street, R. West, 64 cents, 15 cents, $2.12½.

Cobble stone.—Lane, Mercer and Wellington Streets, Ardagh & Leonard, 25 cents per square yard (stone supplied by city); lane between King and Mercer Streets, A. W. Godson, 25 cents; lane north of Colborne Street, Ardagh & Leonard, 85 cents.

The report of a sub-committee was presented recommending that Thorold cement be used for bricks sewers and Portland cement on pipe sewers, and was adopted.

**Upper Mississippi Dredging.**—ST. PAUL, MINN., May 7th.—The work on the dredging of the channel of the Mississippi river, on the west side, between Bole's island and the west shore, began May 6th. The contract is a government one, taken by C. H. Appleton of La Crosse, Wis., who had taken it for $11,560, or 16⅔ cents per cubic yard. The contract calls for the removal of 70,000 cubic yards of material from this channel, but more may be taken if ordered. As the city has not accepted Mr. Appleton's proposition to give the materia taken out for levee or street grading purposes, he will carry it down stream three miles and dump it in the river. Seven hundred cubic yards of material are to be removed each day, and the work will continue for something over three months.—St. Paul *Pioneer Press.*

**St. Paul, Minn., Items.**—The contract for grading Third avenue south, from Twenty-fifth to Twenty-eighth street, was awarded to Smith & Gillett, at 16 cents per cubic yard for average haul of 700 feet, and one cent for each additional 100 feet.

The engineer also reported the proposals received for the construction of a sewer on Washington avenue, from Second to Third avenues north, which were referred to the committee on sewers. The lowest bid being that of E. T. Sykes & Co., at $1.89 per lineal foot, and $3.40 per cubic yard for rock excavation, and the contract was awarded to them.

Bids were received on May 4th., for the Josette and Iglehart street sewers as follows:

Engineer's est., $5,072; P. H. Thornton, $3,800; Stockton & Lindquist, $3,275.50; F. S. Blodgett, $3,712.50; White & Adams, $3,465.50; P. Doherty, $3,457; Toutholt & Hansen, $4,475.60; J. J. Palmer, $3,567; D. Mullen, Jr., $4,635.

Awarded to Stockton & Lindquist.

The bids for grading Robie street were:

Engineer's estimate, $1,000; C. Bahr, $976; Tipler & Tracey, $790; F. Beyer, $986; A. C. Elliot, $899; Ambrose & Segers, $1,050; P. H. Thornton, 990; Peter Tautholt, $969.

Awarded to Tipler & Tracey. The bids for the Jackson street sewer were:

Engineer's estimate, $1,375. J. E. O'Brien, $1,100 Stockton & Lindquist, $999; White & Adams, $1,075. P. Doherty, $1,155; J. J. Palmer, $997; Daniel Mullen, Jr., $1,135.

Awarded to J. J. Palmer. The clerk was ordered to furnish the St. Louis Improved Street Sprinkling company with all necessary information concerning the laws applied to street sprinkling in St. Paul. The plans and specifications for stone sidewalks were approved and the clerk ordered to advertise for bids. The stones that bids will be received on are the North River bluestone, Lamont stone, Peoria, Nininger, Red Wing and Hinckley sandstone, the board refusing to receive any more bids on Euclid or the Malone bluestone, striking it off of the list for good, its lack of endurance in this climate and the poor satisfaction it has given causing this action. The clerk will also advertise for bids for grading De Soto street from Farquier to Collins, and for grading Kent street from University to Minnehaha.

## Railroads, Bridges and Canals.

**The Storm King Bridge** scheme was defeated in the N. Y. Legislature on May 7th, by a vote of 62 to 31.

**St. Gothard Railway.**—The receipts of the St. Gothard Railway in 1884 amounted to 386,221*l.* The working expenses of the year were 184,118*l.*, leaving a net profit for the twelve months of 202,103*l.* After providing for all fixed charges, the directors will be enabled to recommend a dividend upon the share capital of the company for the year at the rate of 1½ or 1¾ per cent. per annum.

**Rapid Transit to Jaimaica, N. Y.**—General Superintendent Barton of the Long Island Railroad said: "In a short time the rapid transit train will run from Brooklyn to Jamaica."

Heretofore the rapid transit trains on Atlantic avenue Brooklyn, have only run to the outskirts of East New York, with occasional trains as far as Woodhaven. When the project now under advisement is perfected, it will give half-hourly trains between Jamaica and Brooklyn.

**A new Proposed Tenn. Narrow-gauge.**—NASHVILLE May 7.—A New York syndicate has purchased 200,000 acres of land in Dickson and Humphreys Counties, which will be settled by Northern colonists and the resources of the section developed. The Nashville, Chattanooga and St. Louis Railway has been offered a bonus of $25,000 to construct a narrow gauge railway from Dickson to the Cumberland furnace, 14 miles distant. When this is done the Indiana, Alabama and Texas Railway will be extended from Clarkville to Cumberland furnace, which, with the Florence and Tuscaloosa, will constitute a good narrow gauge system. The last-named road has already been extended to the border of Wayne County.

**Dubuque & Dakota R. R.**—DUBUQUE, May 3.—The rumors that the Dubuque & Dakota Railroad company would build eastward from Sumner seem to be well founded. The Dubuque & Dakota company expect to tap the Illinois Central road at either Manchester, Dyersville or Farley, with the prospects in favor of the latter. The Dubuque & Dakota at present extends from Hampton to Sumner. From the latter place, a distance of eight miles south-east, the Dubuque & Dakota own a graded bed which they purchased from the Iowa Pacific, and which will be utilized in the completion of the proposed extension from Sumner to Illinois Central road at either of the above mentioned places, a distance of fifty miles. The work of construction, it is said, will commence in a few weeks.

**The Brooklyn Rapid Transit R. R.,** was formally opened to traffic on May 14th. The road so far completed is five miles long, but will be 7¼ miles long when finished. It now is equipped with 45 cars and 22 locomotives.

**Mexican Central Earnings.**—BOSTON, MASS., May 6.—The earnings of the Mexican Central Railroad for April were $306,109. The subsidy collected to date is $3,435,110.

**The San Antonio and Aransas Pass Railway Directory** met May 9th, and let twenty miles of proposed railway for construction. Thos. Johnson, of Houston, a well-known Texas railway contractor, was the lucky man. Construction will immediately commence.

**Missouri River Bridge at Sioux City.**—Omaha papers say that a company has been formed in Boston, to build a bridge across the Missouri River, at Sioux City. Geo. S. Morison, C. E., of New York, has already examined and reported upon the site.

**The N. Y., Pittsburg & Chicago R. R.**—General James S. Negley is reported to be trying to raise a large amount of money in the East to complete the New York, Pittsburg & Chicago Railroad from New Galilee to New Lisbon, a distance of about twenty miles, where they can have a Cincinnati connection.

**Austrian Railroads.**—In Austria 639 miles of new railroad were opened in 1884, and in Hungary 196½ miles, or 835½ miles in all, which is the greatest amount for many years. This makes the total length of railroad in Austro-Hungary 13,630 miles, giving one mile of railroad to 2,776 inhabitants and 16.6 square miles of area.

**The Manchester Ship Canal.**—LONDON, May. 7.—The House of Lords has passed the preamble of the Manchester Ship Canal bill subject to a proviso that £5,000,000 be subscribed before the work is started, and that a deposit amounting to four per cent of the working capital be held in trust until the work of building the canal is completed.

**Assessing Railroad Property.**—The Attorney-General of Arkansas, in reply to the Board of Railroad Commissioners relative to the assessing of railroad property, has decided that the section of the Revenue act of 1883 which excludes from the schedule to be filed by companies a list and value of embankments, tunnels, cuts, ties, trestles and bridges is unconstitutional, and says the board should disregard the attempted exemption.

**A Report on Canadian Railways** shows 9,575 miles of road in operation. The increase in mileage during the past year was not quite as large as that of the previous year, but much greater than in other years. In 1884 there were built 849 miles. The increase in receipts during the year was $177,618, in passengers carried, 402,410, in freight, 446,014 tons. The net earnings were $7,826,872, less by $726,046 than in 1882-3. The decrease is due to the fact that the operating expenses increased $903,664, as against the smaller increase in receipts.

**St. Paul & Northern Pacific.**—The contract for grading the inter-urban line of the St. Paul & Northern Pacific Railroad company has been awarded to Winston Bros., of Minneapolis, the same parties who built the Company's section of road from Sauk Rapids to Minneapolis. The contract covers the grading of the entire line between and within the cities, and all the bridge masonry excepting that for the bridge across the Mississippi.

**Fergus Falls and Moorhead R. R.**—A call has been issued relative to preliminaries to be taken in the matter of a southern railroad to Fergus Falls and Moorhead, Minn., that a meeting of the citizens of Grant county will be held at the office of the clerk of court, in Elbow Lake, on May. 11, for the purpose of considering the question of a railroad to run north through said county, via Fergus Falls, to Moorhead, and to elect delegates to attend a railroad meeting at Fergus Falls.

**The Verdigris Valley, Independence and Western Railroad Company,** was chartered in Topeka, Kan., May. 6th, for the purpose of constructing a standard gauge railway and telegram line from Leroy, via Yates Center, Neodesha, Independence and Sedan to Arkansas City. The place of business will be at Leroy. The names of the Directors for the first year are: Henry Foster, J. H. Pugh, John McCullough, A. C. Stitch and E. Foster, all of Independence, Kan. The amount of capital stock is fixed at $1,000,000. The estimated length of the road is 575 miles.

**The B. & O. in Philadelphia.**—The B. & O. R. R. Co., claim that all the right of way has been secured for its connection through Philadelphia on the east side of the Schuylkill River, and that the assent of the City Council alone is needed to make it a reality. The Councils, however, vigorously object to any work being done until the plans are filed and approved, a formality not yet even commenced. Certain members protest against their "being run over rough-shod" by the B. & O. and think they are treated with contempt. The same gentlemen are conspicuously friendly howe er to the Penna. R. R. A resolution for an injunction to stop work now going on on private property was, after much debate, referred to the Committee on Law and Railroads.

**The Chicago, Freeport & St. Paul.**—FREEPORT, ILL., May 4.—It is currently reported here that the new road known by the name of the Chicago, Freeport & St. Paul, which is to be constructed from Chicago to Freeport and from this point to St. Paul, is to be built in the interest of the Chicago, Burlington & Quincy Company, and that the latter will put the securities in the treasury and issue $10 000,000 of its own debenture bonds to construct the new road.

**Penna. R. R. vs.; B. & O. R. R.**—Officials of the Pennsylvania Road admit that the Baltimore and Ohio has the advantage on distances to certain points, but, they say, this they can readily overcome through their superior roadbed and equipment. The figures are as follows, representing the miles of travel between points of the two roads.

| | Cincinnati | | St. Louis | | Chicago | |
|---|---|---|---|---|---|---|
| | Pa. | B&O | Pa. | B & O | Pa. | B&O |
| New York | 757 | 767 | 1,015 | 1,108 | 912 | 1 041 |
| Philadelphia | 667 | 667 | 975 | 1,018 | 022 | 941 |
| Baltimore | 647 | 589 | 955 | 930 | 812 | 853 |
| Washington | 687 | 551 | 995 | 892 | 853 | 813 |

**For Closing Car Doors.**—An inventive Australian has devised an arrangement by which the doors of railway carriages are closed and kept closed while the train is in motion by a lever worked by the motion of the carriage axle. When the train stops the device ceases to work and the door may be opened. It might be useful in Australia and Europe, where, except in Switzerland and some parts of Southern Germany, the doors of railway carriages are on the side, but would be of no use in this country. In England, however, there is a growing prejudice to the locking of carriage doors, and it is now done on very few, if any, of the lines.

**The Lachine Bridge.**—The Canadian Pacific Railway Company's proposed bridge at Lachine, will consist of 42 spans, eight of which will be 270 feet, and the remaining two 408 feet each. The greater part of the bridge will consist of deck trusses, with the exception of the channel spans, which will be built with lattice sides, thereby giving a view of the celebrated rapids, which begin at the side of the bridge. The foundation is solid rock. The cost will not exceed $2,500,000. A report that the contract had been given to a New York firm is denied by Mr. Van Horne, the general manager of the Canadian Pacific system, tenders not having been invited at present.

**A Proposed New Route to the Pacific.**—Rumors are again current that the Burlington will soon begin work on its extension to the Pacific ocean. The latest route mapped out for the road from Denver is through Boulder Canyon, thence into Middle Park, tunnelling the Continental divide under James Peak. This tunnel will be 9,000 feet long, the longest west of the Mississippi river. It strikes the Grand River Valley several miles below the mouth of the Blue, thence it proceeds down the Grand to Grand Junction, and through Utah and Nevada to California. Some work has been done on the grade in the Boulder canyon and Middle Park. The tunnel through James Peal will take at least two years to build.

# Market Report of Engineering Materials.

**New York, May 14, 1885.**

NOTE.—The following Market Report gives wholesale prices on the New York Market unless otherwise stated. It is intended as a general guide to the estimating engineer, and both the range of material and the market location will be extended as rapidly as possible. We give it with this caution, that, as is well understood in business transactions, the amount of bill, distance from market centre and conditions of payment will have a material influence on the final paying prices.

## IRON.

| | | |
|---|---|---|
| STRUCTURAL IRON. | | |
| Angles | 1.9c. @ | 2.2c. |
| Tee | 2.2 @ | 2.25c. |
| Beams and channels | 3.0c. @ | |
| Tank | 2.1c. @ | 2.15c. |
| Shell | 2½c. @ | 2¾c. |
| Steel plates, Tank | 2¾c. @ | 3c. |
| WROUGHT-IRON PIPE. PITTSBURGH. | | |
| Butt welded, black ..Discount | 50 | |
| " " galvanized " | 40 | |
| Lap welded black " | 67½ | |
| " Galvanized " | 50 | |
| Boiler tubes " | 60 | |
| RAILS. | | |
| Steel (large lots at mill) | $26.50 @ | 27.00 |
| Old rails | 16.50 @ | 17.00 |
| Oldrails, steel | 17.00 @ | 17.50 |
| R. R. spikes | 1.8 @ | 1.9c |
| R. R. splice-plates | 1.65c. @ | 1.75c. |
| R. R. Track Bolts | 2.6c. @ | 3c. |
| Barb-wire fencing, galvanized | 4½c. @ | 5½c. |
| " " painted | 3¾c. @ | 4¼c. |
| Corrugated iron | | |
| Nails | | |
| Iron | 2.25 | |
| Steel | 2.25 | |

## METALS.

| | | |
|---|---|---|
| COPPER. | | |
| Lake Superior | 11¾ @ | 12 |
| Other Brands | 10⅞ @ | 11½ |
| LEAD. | | |
| Com. Domestic | 3.65 @ | 3.70 |
| Lead Pipe | .05¾ | |
| Tin-Lined Lead Pipe | .15 | |
| Sheet Lead | .06¾ | |
| ZINC. | | |
| Sheet | 0.05 @ | 0.05½ |

## BRICK.

| | | |
|---|---|---|
| (Cargoes afloat) | | |
| Haverstraw 1st per M. | $5.75 @ | 6.25 |
| " 2nd " " | 5.62 @ | 5.87 |
| Fishkill | 4.75 @ | 5.50 |
| Up-River | | |
| Jerseys | 5.25 @ | |
| Long Island | | |
| " pale | | |
| FRONTS. | | |
| Croton red | 14.00 @ | |
| " dark | 14.00 @ | |
| " brown | 12.00 @ | |
| Philadelphia pressed | 22.50 @ | 23.00 |
| Trenton " | 22.50 @ | 23.00 |
| Baltimore " | 37.00 @ | 41.00 |
| Buff " | 33.00 @ | 35.00 |
| Enameled English | 65.00 @ | 130.00 |
| " American | 85.00 @ | 120.00 |
| Fire brick | 25.00 @ | 40.00 |

## CEMENT.

| | | |
|---|---|---|
| PORTLAND. | | |
| Gibb's English 400 lbs. per bbl | 2.75 @ | 2.90 |
| K. B. & S. " " | 2.85 @ | 3.00 |
| Burham " " | 2.70 @ | 2.85 |
| Keene's fine " " | 9.50 @ | 9.75 |
| " course " " | 5.25 @ | 5.75 |
| Roman | 2.75 @ | 3.50 |
| Langerdorfer German " | 2,90 @ | 2 65 |
| Dyckerhoff, " " | 2.60 @ | 2.65 |
| Stettiner " " | 2.60 @ | 2.65 |
| Verwohler, Lion " " | 2,60 @ | 2.65 |
| Alsen, " " | 2.55 @ | 2.60 |
| Fieve " " | 2.40 @ | 2.50 |
| Saylor's American | 2.15 @ | 2.40 |
| Windsor } U. S. C. Co. | 1.00 @ | 1.10 |
| Standard } U. S. C. Co. | 1.35 @ | 1.50 |
| Cable's Portland } | 2.15 @ | 2.40 |
| ROSENDALE cements | 1.00 @ | 1.10 |

## LIME.

| | | |
|---|---|---|
| Rockland common per bbl | 1.00 | |
| " finishing | 1.20 | |
| Glensfalls, common | .85 | |
| " finishing | 1.05 @ | 1.10 |
| Kingston, ground | 0.95 | |

## STONE.

| | | |
|---|---|---|
| *Cargo rates at New York.* | | |
| Amherst freestone, No. 1 per cub. ft. | 0.90 @ | 95 |
| " " No. 2 " | 0.75 @ | 0.80 |
| " " light drab " | 0.80 @ | 0.95 |
| Berlin " in rough " | 0.75 @ | 1.00 |
| Berea " " | 0.75 @ | 1.00 |
| Brownstone, Portland, Ct. " | 1.00 @ | 1.30 |
| " Belleville, N. J. " | 0.75 @ | 1.25 |
| Granite, rough | 0.60 @ | 1.25 |
| Common building stone per load | 2.00 @ | 3.00 |
| Base stone, from 2½ to 6 ft. lengths, per lin. ft. | 0.40 @ | 3.00 |

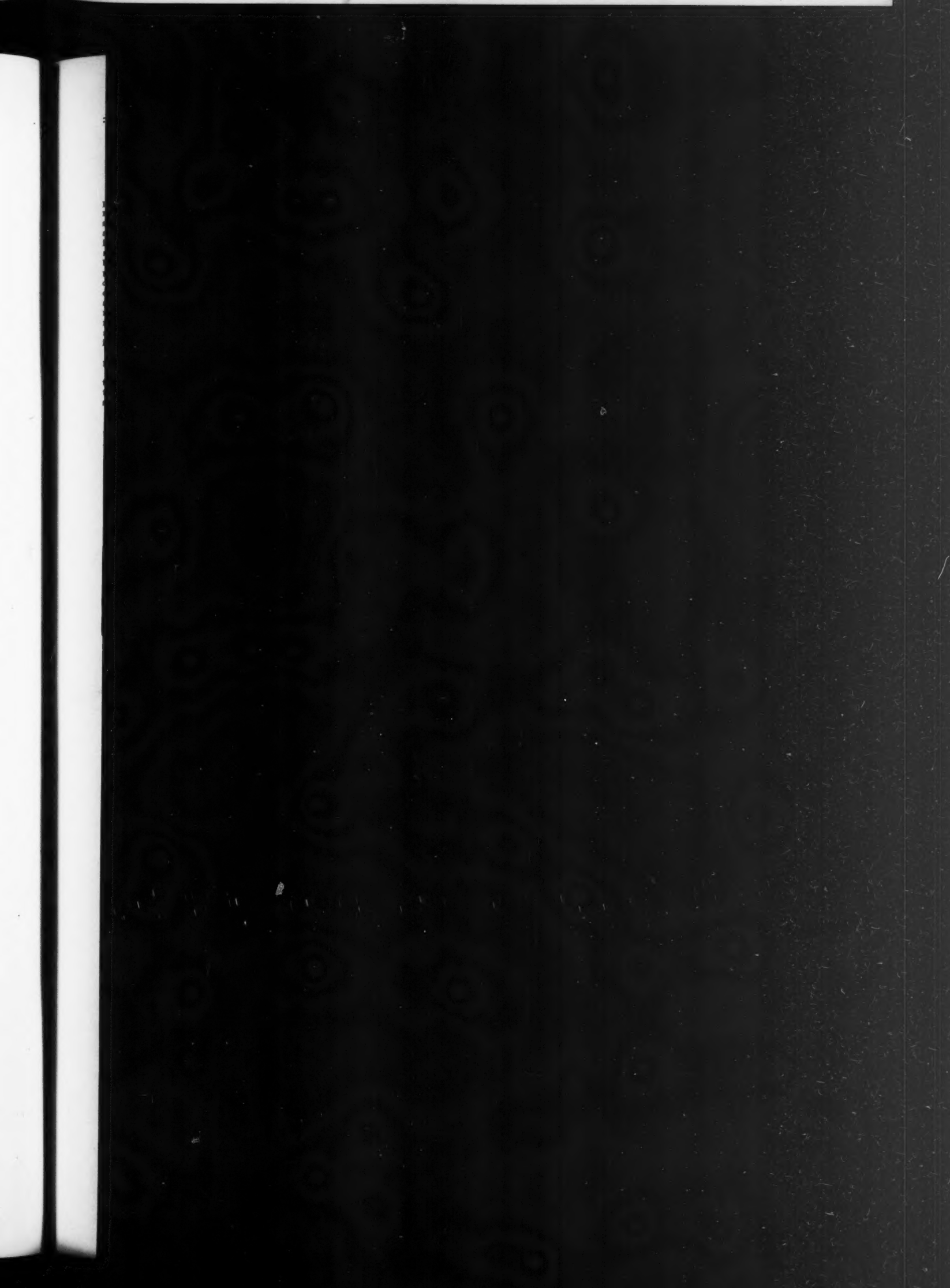
## SLATE.

| | | |
|---|---|---|
| Purple roofing per square | 6.00 @ | 7.00 |
| Green " | 6.00 @ | 7.00 |
| Red " | 15.00 | |
| Black Penna. (at New York) " | 4.50 @ | 5.00 |

## LUMBER.

| | | |
|---|---|---|
| PINE, Common box per M. | 18.00 @ | 20.00 |
| Good " | | |
| Tally plank, 1¼ in each. | .44 @ | .50 |
| Tally boards, dressed com. " | .28 @ | .30 |
| SPRUCE, Boards dressed " | .25 @ | .28 |
| Plank, 1¼ in " | .28 @ | .30 |
| " 2 in. " | .38 @ | .40 |
| " 2 in. dressed " | .43 @ | .45 |
| Timber per M. | 20.00 @ | 22.00 |
| HEMLOCK, Boards each. | .18 @ | .20 |
| Joist, 2½ × 4 to 4 × 6 in | .17 @ | .44 |
| OAK per M. | 55.00 @ | 65.00 |
| CYPRESS 1, 1¼, 2 and 2½ in " | 35.00 @ | 40.00 |
| YELLOW PINE, Girders " | 26.00 @ | 35,00 |
| Dressed flooring " | 30.00 @ | 40.00 |
| SHINGLES, Extra shaved pine, 16in. " | | |
| " sawed 18 in. " | 4.50 @ | 5.00 |
| LATH, Cargo rate " | 2.40 @ | 2.50 |

## PAINT.

| | | |
|---|---|---|
| Lead, white, American dry per lb | .04¾ @ | .05 |
| " " " in oil pure " | .05½ @ | .05¾ |
| English, B. B. in oil " | .08½ @ | .08¾ |
| Red, American " | .05½ @ | .05¾ |
| Litharge " | .05 @ | .05¼ |
| Venetian red, American " | .01 @ | .01¼ |
| Indian red " | .05 @ | .10 |
| Vermillion, American lead " | .11 @ | .11¾ |
| Paris green " | .15 @ | .19 |
| Umber, Amer. raw and powdered per lb. | .01¼ @ | .01½ |
| Drop black, Amer. " | .08 @ | .12 |
| " " " " | .09 @ | .11¾ |
| Chrome green " | .05 @ | .15 |
| Oxide zinc, American " | .03¾ @ | .04 |
| " French " | .06¼ @ | .06½ |

**DURABLE TIMBER.**—A piece of white oak pile that formed a part of the foundation of the Pennsylvania Railroad bed through the quicksands of the Gap between Lancaster and Chester Counties, Pa., is now lying on the Pennsylvania depot platform, and is curious on account of its wonderfully well-preserved condition. It was placed in position 50 years ago, but does not show the slightest signs of decay.